POWER PLANT ENGINEERING

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Parsi Hocus-Pocus

Shades of Zoroaster—what have we here! Voodoo hocus-pocus or we'll eat our hats. So this is where the Parsi devils hang out, eh—in Schenectady, of all places! And what a hang out—just look at it! Did you ever see a more devilish place in all your life? Just look at those instruments of torture. The two star cast? Well, we don't know for sure but the Ku Kluxer in the center looks like Merlin himself. The varlet on the right no doubt is his chief research chemist disguised as Lon Chaney. He probably concocted the potion of viper and toad broth in the can at the left—the one with the Ingersol stuck on top.

What's this all about? Well, we don't know that we've got the story straight but anyway it seems that in the 7th or 8th centuries the Mohammedans chased the Parsis out of Persia. The Parsis, you see, were followers of Zoroaster, a gang of fire worshippers who persisted in violating all the rules of the Persian Board of Fire Underwriters. So the Fire Chief who was in solid with the Shah got mad and chased the Parsis out of the country. Being all dressed up for a fire and with no place to go the Parsis settled in Bombay and that's the last we heard of them. Things must have been slow in Bombay, however, for last week we received this picture from the General Electric Co. and from this it is quite apparent that the Parsis rented a basement apartment in the Research Laboratory and have been conducting their cabalistic activities there. But even in Schenectady they could not escape the persecution of the Board of Underwriters and when the fire chief broke down the door and took this picture, there they were, caught red handed in a two handed game of black magic.

Of course they had an alibi. From under their fur-lined straw hats they announced that they were research men of the General Electric laboratories and that they had just developed a method of atomizing oil in which a single drop of furnace oil, no bigger than the head of a match, is broken into more than 100,000,000 particles. A good story? Indeed, read about it on page 608.

WITH THE EDITORS

Government Nonessentials

BECAUSE OF INCREASE of governmental expenditure, federal, state and local, until tax levies are 30 cents out of every dollar of income—beyond the ability of business organizations and individuals to pay—opinion is rapidly crystallizing in a demand for reduction of such expenditure and of nonessential government activities. As is the case for individuals and families, many luxuries are nice to have that ought not to be afforded and which, if bought, will result either in bankruptcy or in later privation to pay the cost. Borrowing to buy nonproductive nonessentials is a sure cause of trouble as is evidenced by the present condition of many South American and European countries, states and cities. Indeed our own condition is rapidly trending that way and in some communities has arrived.

In 3 yr. national income has *decreased* two thirds while taxes have *increased* one third. Decrease in income has been due to diminishing business caused, in part at least, by burdensome taxation and government meddling. It has become a custom to run to governmental agencies whenever a problem seems difficult to handle, when help is wanted for local improvements or when we feel that bad habits need reforming.

As those whom we have placed in office have been anxious to please us, especially when by so doing they could increase opportunities for political patronage and favoring of friends, governmental agencies have multiplied alarmingly in both size and number. To a considerable extent, we, the people, have been to blame because of our demands on government for assistance. Now that we realize that such assistance is costing too much and that we can't afford it, we must decide what we will do without and acquiesce in retrenchment. It's no good insisting that the reduction in activity all be in matters that affect somebody else.

Undoubtedly much can be saved by combining and better organization of departments and bureaus. To cite an instance near home, Cook County, Illinois, has a county board, a forest preserve, a sanitary district, all covering practically the same territory, none economically and some extravagantly managed, with multiplication of officials, office forces and equipment. Combination of the three could unquestionably yield economies, while reorganization to cut down political jobs in the management and operation would result in vast savings. But political offices and patronage would be decreased and some prerogatives of communities would have to be surrendered—so nothing has been done.

Consolidated public opinion, emphatically expressed, is the only force that can start things moving in the right direction. It is time that the mistreated majority of the people become active to throw off the rule of the loud-speaking minorities and blocs, which have to a great extent gained control of government activities.

It is time to take stock of governmental departments and bureaus, to determine which ones are essential to general welfare; to cut out nonessentials and so to organize the remaining activities that they are operated with greatest economy and effectiveness.

If we are to avoid and overcome impaired credit in federal, state and local governments, solvency must be accomplished. The biggest step is by eliminating nonessential government expenditure.

Unit Costs—A Challenge Answered

WHEN GIFFORD PINCHOT sent an open letter to the American Institute of Electrical Engineers couched in such language as to be a demand for distribution costs of electricity to household consumers, he was no doubt aware that the information was not available at that time. The incident received so much publicity that politicians throughout the country cited as one of the nefarious practices of the power industry to hold back information which belonged to the public. Then came this sensational and rather startling statement at the last International Conference on World Power by Frederick M. Sackett, United States Ambassador to Germany: "I know of no other manufacturing industry (than the electrical) where the sale price is fifteen times the actual cost of production."

While such an attack on the industry was neither true nor justified and only demonstrated lack of accurate information and analysis of the man who made it, nevertheless it did start in motion mental forces which have brought consent of the industry's executives to publish the average itemized unit costs of electric power and service from the switchboard to the householder's meter. Here they are as generally applied by N.E.L.A. members to urban areas where a density of 2000 customers per square mile may be found:

Generating electricity	0.47	cents
Fixed charges on the generating station system that produces electricity	.78	"
Transmission and substation operation	.16	"
Fixed charges on transmission and substation equipment	.33	"
Cost of operating distribution lines from the substation to the consumer's meter	.29	"
Fixed charges on the distribution equipment	1.45	"
Reading meters, preparing bills, collections, service calls and business administration	1.80	"
Total cost of kilowatt hour, per unit of electric service, at consumer's meter	5.28	"

This direct answer to Mr. Pinchot's challenge is typical of the engineering profession in all its branches. The entire profession bases its activities on facts and the valuable information which engineers withhold from publication is extremely meager. Probably no one feature of the conduct of the privately owned public utilities has caused more controversy with the public than their apparent desire at times to secrete actual costs. Certainly the industry can explain its charges if any business can. The figures given clearly show that cost of electricity in the home is more for a service than for a commodity.

Suggestions for Profitable Reading

They Blew Soap Bubbles in Texas

Can you imagine a gang of full grown men disporting themselves blowing soap bubbles? No? Well, neither could we, but believe it or not, that's just what a group of engineers were doing not so long ago down in Texas, in the middle of a desert, of all places. Why? Well, how do engineers do anything? Usually, of course, they have some high powered alibi to excuse their childish antics but often, we think that's all they are—just good excuses, the fact of the matter is, they like to play.

In this particular instance, the alibi was the Eagle Pass Hydroelectric Development, a new 12,000-kv.a. ultra modern plant taking water from the Maverick Irrigation District canal. Just why the canal was given this name we don't know but it isn't well named for there is nothing resembling a maverick about it; the water must be paid for—and paid for whether it is used or not. For this reason, the plant was built extra special and super-reliable—water in Texas is worth money and should not be wasted.

This station has many interesting features; one shot greasing, concealed lighting, hidden crane rails, sure-fire spillway control, penstocks with no intermediate anchors and incorporation of the taper at the turbine inlet at the elbow—these are but a few of the interesting innovations which made the description on page 582 valuable to anyone interested in the latest hydraulic development. Even the interior decorative scheme is *different,* unusually attractive and what is more interesting, done at remarkably low cost.

The soap bubbles? Oh, yes, we almost forgot—they were used in testing the penstocks, at least that's what the engineers say. They had a perfectly glorious time, blowing them with an air compressor.

Parallel Operation Again

One would think that, after all these years of operating alternating current generators in parallel, everybody would know all there was to be known about this practice. Our experience, however, proves that this is not true for every once in a while somebody brings up the subject from a slightly different angle and Presto! there opens up a controversy that lasts for months. An incident of this kind occurred recently. In the April 1 issue one of our subscribers asked a comparatively innocent looking question as to what happened when the field switch opens on one of two alternators running in parallel. Now, it appears that this actually occurred in the plant he was operating and nothing serious "happened," but an argument arose among the operators and so he sent the question to us. Well, since then we have received a flood of letters, commenting on the problem, no two of which really are alike. We have published some of these and others are to follow.

It is not our purpose here to discuss this particular problem but we mention it because it shows how much interest there is in this subject and how much room there is for more intelligent discussion of the problem. And so also we wish to direct particular attention to the series of articles on Parallel Operation of A.C. Generators by E. H. Stivender which we have been presenting during the past year, one of which appears in this issue. Mr. Stivender, who has had a wide and varied experience in the installation and operation of electrical equipment of all kinds, appears to have an unusually keen insight into the problem of parallel operation, and his articles discuss the subject from many angles. In the article in this issue he discusses the question of phase shifting. This is just one of those little tricks of the trade, the knowledge of which makes the difference between a good operator and an ordinary one.

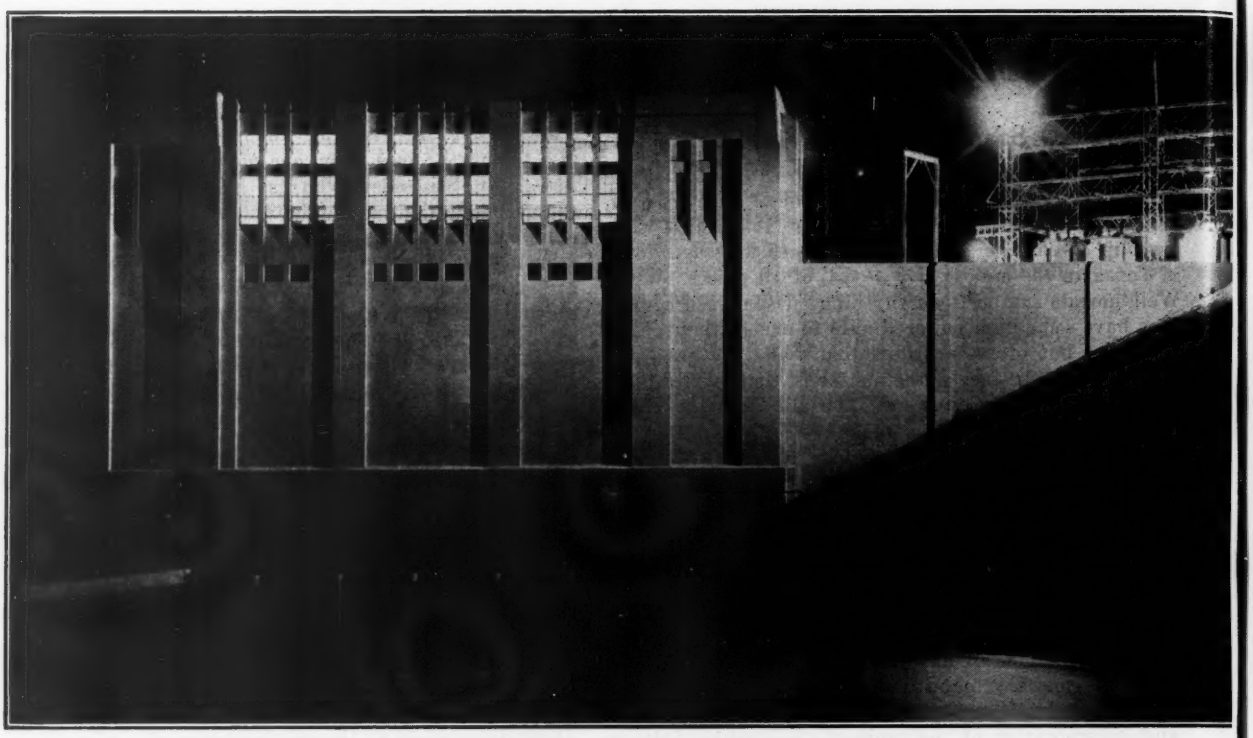
Anything Wrong with Your Joints?

By common consent joints are not considered topics of polite conversation unless they happen to be the nice juicy variety that the true Englishman revels in. Outside of this, joints usually mean rheumatism, arthritis, gout or something of that sort and these are not pleasant topics. Still, in this issue, with all the enthusiasm of a life time of fearless and honest endeavor, Edward J. Kunze boldly attacks joints of all kinds and discusses them frankly and knowingly. A rheumatic Diesel engine is more than worthless and so Mr. Kunze has set about discovering all the suitable types of joint packings to banish this ailment from the power plant forever.

A Complex Business

Modern large scale production of electrical energy is a complex business, despite the fact that countless gadgets have been provided to make plants almost entirely automatic in operation. These gadgets, it is true, relieve the operators of nearly all the manual labor which used to be a part of their lot but at the same time they demand increased knowledge and skill. It takes more brains to understand a complex combustion control system than it does to keep steam up in a hand-fired boiler. In this issue Alex Bailey discusses the factors involved in modern electrical energy production. Unit cost of stations he points out is decreasing but distribution costs are increasing. Cost of service includes more than operation and distribution. Meter reading, keeping customers' accounts, billing, for domestic service at least, may cost as much as the generation and delivery of current. Despite this, rates have steadily come down.

As a person interested in the art, if you please, of power generation, you should read this article, for if nothing else, it will provide you with a better background for your particular work in the field. Perhaps many of the things Mr. Bailey discusses have no direct bearing on your work, but how much of what you read has? This article will provide you with a better perspective and if one needs anything these days we certainly need that. What, for instance, do you know of the relation of water power to steam in the field of power production. Mr. Bailey shows that fuel has gained in relative importance compared to water power, still water power accounts for ⅓ of the total kilowatt hours produced. What position do older stations occupy in the field compared to the new stations? What is the effect of interconnection?



EAGLE PASS Hydro-electric Development of the Central Power & Light Co., completed in May of this year, is located on the north bank of the Rio Grande River, 10 mi. northeast of Eagle Pass, Tex., and 160 mi. southwest of San Antonio. Water for the development is obtained from the main irrigation canal of the Maverick County Water Control and Improvement District No. 1, which at this point swings to within 1500 ft. of the river at an elevation of about 85 ft. above low water stage. Water is diverted from the Rio Grande and flows through about 32 mi. of canal to the point of delivery where the District has provided a check structure and head works for the power canal.

Designed capacity of the irrigation canal above the power canal diversion is 1500 c.f.s., and the proposed extension below this point will have a capacity of 500 c.f.s. Not less than 1250 c.f.s. is to be delivered continuously for power during the first 10 yr. and not less than 1000 c.f.s. continuously during the next 30 yr. Outside of the irrigation season it is contemplated that 1500 c.f.s. will be delivered for power.

Figure 1 shows the general layout of the power development as constructed. There is no pondage along the canal such as would permit operation of variable load, or the shutting down of a unit more than momentarily when water is available. As water available for power must be paid for when wasted, these conditions made it imperative that the maximum operating reliability be obtained. Accordingly three units were installed in the power house, permitting one to be off the line for inspection or repairs during periods of low flow.

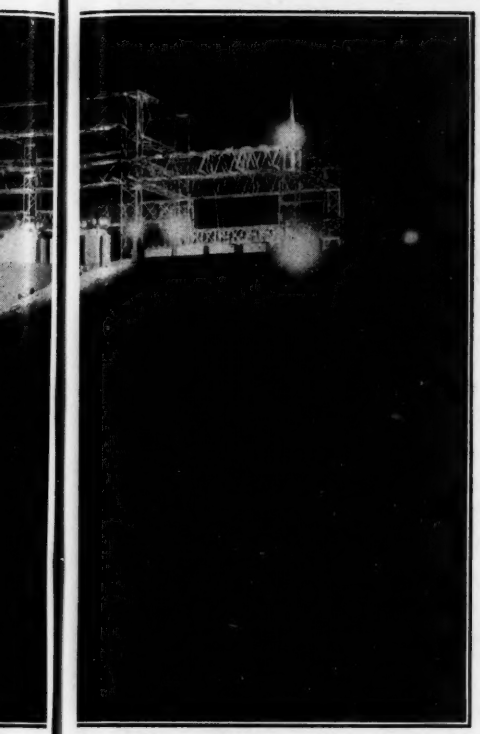
All mechanical features throughout were made as reliable and as accessible as possible to encourage proper maintenance and to facilitate repairs when necessary. At this point the Rio Grande has a range of stage of from El. 712 in low water to about El. 750 in extreme high water. The interior of the power house and all equipment is protected against water to an elevation of 760 and the generator floor was placed at this elevation. Normal headwater is at El. 796.7 and will fluctuate but little from this.

Headworks and Canal

At the point of diversion from the irrigation canal, the irrigation district constructed concrete headworks for the power canal, combining with them a check structure in the irrigation canal for the purpose of maintaining constant headwater elevation. These structures are of conventional design, the headworks having four openings 16 ft. wide, closed by vertical truck type gates operated by hand power hoists. From the headworks to the penstock intake the power canal has a length of about 1250 ft. It is located along the crest of a narrow clay spur having steep side slopes dissected by several deep arroyos leading down to the river.

Spillway

As the spillway is the only point along the irrigation canal at which water can be readily wasted, provision was made to discharge the maximum flow of 1300 c.f.s. at normal headwater elevation. This spillway consists of a Tainter gate 11 ft. deep by 12 ft. wide on top of a weir in the side wall of the transition section, adjacent to the left end of the intake. From the weir a concrete chute 12 ft. wide extends down a natural depression into a concrete stilling pool, with a total drop of 67 ft. from headwater to water level in the pool. The discharge from this pool ponds in a ravine and is controlled by an open crest weir over which it falls 17 ft. into a second



EAGLE PASS Hydroelectric Development

Three 4000-k-va. Units Operate in Conjunction with Irrigation System. Penstock, Spillway, Turbine and Plant Interior Have Noteworthy Features.

By L. F. HARZA and J. S. BOWMAN
Harza Engineering Co., Chicago, Ill.

stilling pool which discharges into the tail race. This arrangement of spillway was dictated by topographical conditions and the second weir forms a barrier at the mouth of the gulley which prevents natural wash from the hills from sluicing debris into the tail race.

Tainter gate is of conventional design. It is overbalanced by a concrete counterweight to which it is connected by chains passing over sprocket wheels on the overhead hoist. The hoist is motor operated and normal control is automatic through a float and electrical step contacts. The automatic control may be superseded by manual push button control from the switchboard room or from the platform above the gate.

Normally the gate is held in any position by a solenoid brake acting against the excess torque of the counterweight. In event of entire current failure at time when the gate must be opened the solenoid brake can be tripped mechanically. As a further provision against possibility of over-topping the canal banks, a means for automatic opening is provided by a weir overflow to a bucket which when full will trip the solenoid. In order to prevent the counterweight from coasting at excessive speed, a fan with a damper in the casing outlet is direct connected to the driving shaft of the hoist and is normally set to limit the coasting speed of the counterweight to 2 ft. per min.

Intake

Particular care was used in the design of the intake to reduce entrance loss to the penstocks to a minimum by making the changes in velocity head as nearly constant and as gradual as possible. Trash racks are made up of round edge bars welded into frames, forming removable sections which are held in place by grooves in the piers. The three head gates are 14 ft. 7½ in. wide by 13 ft. 3¼ in. high, rolling on four truck wheels 18 in. in diameter. They are built up entirely of welded members which gave a very economical and neat job. The hoists are motor driven, crane type, mounted on overhead steel towers. They are operated by push button control either from the intake deck or from the switchboard room.

Penstocks Have No Intermediate Anchors

Penstocks are of riveted plate steel 11 ft. in diameter. Due to the low cost of material and the relatively low head, it proved economical to limit the maximum velocity to 6.5 ft. per sec. to avoid high friction losses.

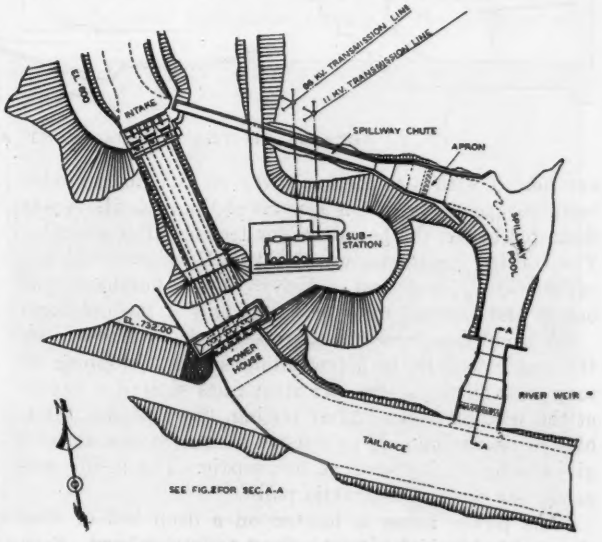


FIG. 1. GENERAL LAYOUT OF THE EAGLE PASS DEVELOPMENT AS CONSTRUCTED

The taper to the turbine inlet at the lower end was incorporated in the elbow, as it was believed the increasing velocity would reduce the tendency of the elbow to create disturbance. The net head piezometers installed at the quarter points on the turbine inlet gave identical readings, indicating that very little disturbance was caused by this design of elbow.

Stiffeners of 5 by 3 by ⅜ in. angles are used every 8 ft. on the upper section and every 4 ft. on the lower section. All transverse joints are double riveted in order to take temperature stresses as no expansion joints and no intermediate anchorages were used. The penstocks are buried with a minimum cover of 2 ft. to minimize temperature changes. On account of the back fill, it was desirable to test the penstocks for leakage after erection. The turbine scroll case was filled with water to the top of the speed ring and a heavy timber bulkhead was bolted and caulked into the upper end of the penstock.

A small compressor then raised the air pressure on the inside to 5 lb. in a few minutes and a mopping of soap suds on the seams and rivet lines showed a bubble at the smallest leaks. After testing, the pipe was sandblasted on the outside to remove all rust and scale and given a heavy hot coat of bitumastic. The inside was given two coats of hydraulic paint.

The power house is located on a deep bed of blue clay or shale which rises to about tailwater level. Both the substructure and superstructure are constructed of concrete, the considerations of durability, convenience and architectural appearance being given careful study throughout. The roof is red cement tile; the sash, steel; and the doors, hollow metal. The generator room and switchboard room floors are terrazzo and a terrazzo wainscot was used on the walls. The crane girders and vaulted roof trusses were metal lathed and plastered, using simple mouldings to accentuate the horizontal lines.

Interior lighting is indirect, being accomplished by lights concealed behind a cove in the switchboard room and behind the crane girder in the generator room. These are reflected from the curved ceiling to the floor, giving a pleasing and adequate distribution of light. Ventilation of the building is accomplished by pulling cooling air for the generators in through the windows.

Generators discharge into a duct from which the heated air passes to the outdoors through louvers in the downstream side of the building. An exhaust fan pulls the air from the lower substructure floors to which fresh air is supplied through grilles in the generator floor. During cold weather the outside louvers in the discharge duct may be closed and sufficient warm air recirculated through registers into the power house. A 30-ton electric crane with a 7½-t. auxiliary hoist is provided for handling machinery and is operated by means of pendant controls from the generator floor.

It was necessary to locate the power house well down

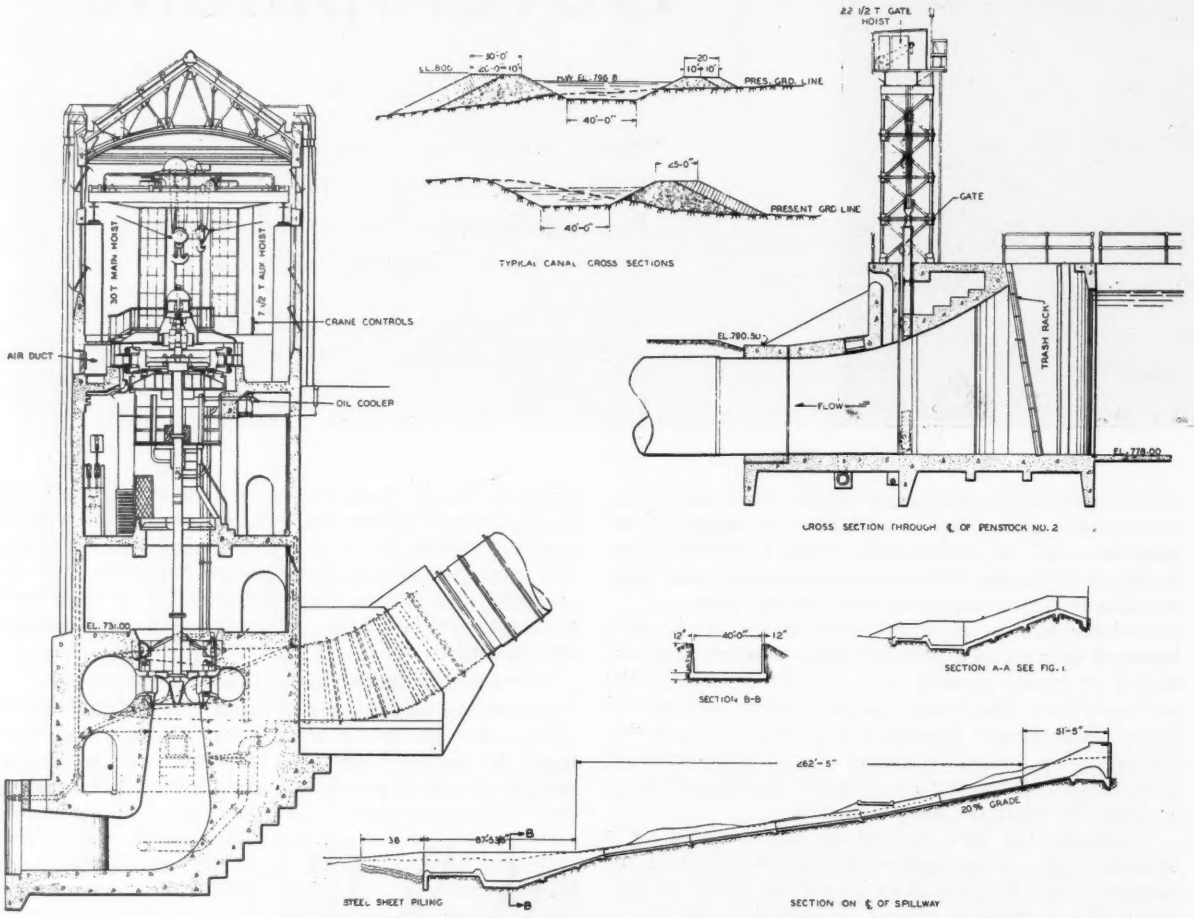


FIG. 2. DETAILS OF THE DEVELOPMENT AND CROSS SECTION OF THE POWER HOUSE

FIG. 3. CRANE RAILS, CRANE BRIDGE AND ROOF TRUSSES HAVE BEEN COVERED OVER AND ALL LIGHTING IS INDIRECT. THIS SETS A NEW STANDARD FOR AMERICAN POWER PLANT INTERIORS

on the foot of the hill to avoid heavy excavation and to secure a proper approach for the penstocks. As high river stages would have then passed between the power house and the hillside a considerable problem was presented in obtaining a means of ready access, in preventing damage from scour and in preserving a good appearance. This was solved by extending retaining walls from both ends of the power house, which were sealed into the hillsides up to the height of the generator floor. The space between was then backfilled, burying the penstocks and providing ample level space along the right end and upstream side of the power house as well as additional area for the substation.

The switchboard room occupies the left end of the power house adjacent to the substation and highway approach. At the opposite end ample erection space is provided on all three floor levels to which the crane hooks have access through hatchways.

Turbines

Turbines are the vertical direct connected type with Francis runners, having a specific speed of 64. Each runner develops 4775 hp. under 81 ft. head at a speed of 225 r.p.m. The discharge of each unit at 81 ft. net head is 615 c.f.s. An homologous runner 38 in. diameter gave a maximum efficiency of 94.57 per cent in the Holyoke flume and this was closely approached in a test of the 56½ in. diameter runner in place.

Scroll case is of plate steel construction. The draft tube is of the curved type and is provided with an inspection manhole in the liner immediately below the runner. Access to this manhole and to the scroll case drain valves is afforded by galleries at the 731 floor level.

A new feature in this installation is the use of a Farvel unit lubrication system for one shot greasing of all points on the gate stems, links and shifting ring. A new system was also developed for packing the gate stem, which greatly reduced leakage at this point and which it is believed may lead to considerable change in present design. The gate shifting ring is located on the inside circumference of the pit liner instead of around the bearing as is customary. This leaves the pit unobstructed and permits ready access to the turbine bearing without dismantling the shifting mechanism.

Generators

Generators are of the umbrella type, having a combined thrust and guide bearing below the rotor. Each machine has a capacity of 4000 kv-a. at 0.8 power factor; generation is at 60 cycles and 6900 v. Welded construction was used throughout but particular care was exercised to secure proper proportions and a pleasing exterior appearance.

Ventilating air is taken in at the top of the generator near the shaft and discharged outward through the coils into a plate steel duct which surrounds and forms an integral part of the machine. This duct in turn discharges into the masonry duct before referred to in connection with the power house ventilation. Canal water is circulated around pipe coils for cooling the thrust bearing oil. High speed excitation is used.

Instead of being supported on a concrete barrel carried by the turbine speed ring, the generators in this case are supported on heavy beams carried by the walls. This proved to be the more economical means of support on account of the great height between the turbine and generator floors at the same time the intermediate floors remain roomy and unobstructed.

Governors are of the vertical actuator type located on the floor beside the generators. Each is provided with individual pump, pressure tank and sump, the sumps being incorporated in the pump bases and the pressure tanks being suspended beneath the generator floor for the sake of appearance and to economize floor space. The governor flyballs are motor driven by current from a pilot exciter on the generator main shaft. Dual control is used for controlling the gate opening and setting the gate limit stop so that either of these adjustments may be made by the operator, remotely from the switchboard where an instrument indicates both, or directly at the actuator. Location of the pressure tanks below the generator floor does not permit direct reading of the oil pressure and level. Therefore, remote indicating pressure and level gages were installed on the tanks with duplicate indicators on the actuator column and on the switchboard, so arranged that oil level is ordinarily indicated, but by pushing a button, oil pressure is indicated on a second scale by the same instrument.

As the usual tachometer on top of the actuator col-

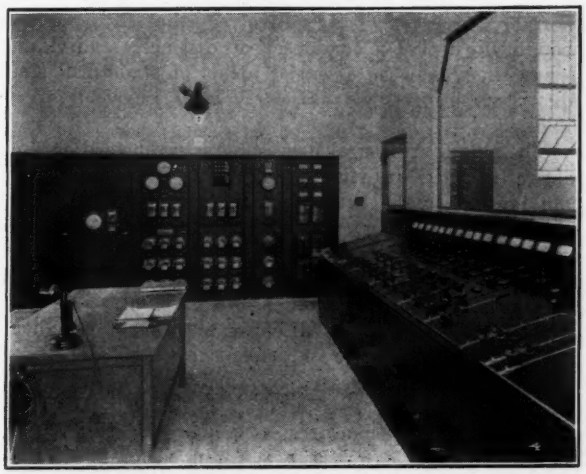


FIG. 4. THE CONTROL ROOM. THE OPERATOR AT THE BENCH BOARD LOOKS OUT THROUGH A PLATE GLASS WINDOW AT THE TURBINE HALL

umn could not be read from the switchboard room and as frequency will indicate the speed of a unit at all times, the tachometer was replaced with a light on each actuator which comes on when the flyballs are up to speed and indicates to the operator when the governor takes control.

In planning the switchboard room and its equipment the principal considerations were to place all operations of the plant under the control and observation of one operator with no necessity of leaving his station and to make all instruments and circuits convenient and accessible. All instruments and controls are on a bench-board facing the end of the generator room which is always under observation through a large window running the entire length of the board. From this station the units can be thrown on and off, the load adjusted and the governor controlled, all operations being indicated by illuminated instruments. All circuits are led into a trench, beneath the board, in which a man can stand full height. The meter and relay board is recessed flush with the downstream wall and each panel is hinged to swing outward for accessibility. All boards are constructed of pressed furniture steel. The bus structure and battery room are located on lower floors immediately below the switchboard room.

On a hydraulic control board are located the controls for operating the intake headgates, a system of colored lights indicating the position of the gates at all times. On the same board is a switch by which the spillway gate can be remote controlled or placed on automatic control. Immediately above this board are instruments which indicate and record head and tailwater levels and the opening of the spillway gate. Flow meters and manometers are used for indicating and recording the discharge of each turbine, each of these being connected to two piezometers located on different radii of the scroll case according to the Winter-Kennedy Method, and actuated by the differential pressure so established. The flow meters and manometers were calibrated for discharge during the Gibson tests.

Manufacturers

Generators, switchboards and switching equipment were furnished by the Westinghouse Electric & Manufacturing Co., the turbines by the James Leffel & Co.; and the governors by the Woodward Governor Co. The Cleveland Crane and Engineering Co. furnished the crane and intake gate hoists; Lakeside Bridge & Steel Co., the intake gates and the spillway gate end hoist; Meyer Governor Co. the Teldicators for remote recording of water levels, etc.; the Simplex Meter & Valve Co. the flow meters; Wyatt Metal & Boiler Wks., the penstock.

Personnel

The development was constructed for the Central Power & Light Co., of San Antonio, Texas, Mr. J. T. Persons, chief engineer, by Bart Moore Co., general contractors of San Antonio. C. E. Wattles was resident engineer for The Harza Engineering Co. of Chicago, designing and supervising engineers.

Balanced Natural Flow Condenser Development

New Condenser Design with Rectangular Tube Bundle and Simple Construction Has Many Novel Features. By John H. Smith*

WHILE THE WRITER has been active in the invention and promotion of many of the largest condensers now in service involving the converging lane principle of tube arrangement, staggered tube supports, and various forms of artificial resistance in an attempt to regulate and control the flow of steam through compartments formed by tube supports, it was recognition of the obscurity to which these media relegated the thermal and physical laws involved, that fathered the thought to evolve a condenser of distinctly individual design, in which the essential ideals of structural simplicity are approached as nearly as is physically possible.

The balanced natural flow condenser shown diagrammatically in the drawing is believed to be an important contribution to the art of condenser engineering, and while the writer believes it to be but a step toward spanning the wide gap in the direction of the ideal, he, as well as others so engaged will continue to explore this wide field in search of further improvement.

Obviously this design discloses nothing of a radical nature. As in the case of present practice, a shell, or condensing chamber, having the various essential flanged openings encloses a tube bundle. It is the relative arrangement of these features, as evidence of full regard for fundamental laws, that is intended to afford improvement in the fields of operation, testing and maintenance.

Flow Features of Design

First feature of note is the parallel arrangement of tubes, thus removing the throttling effect, or area reduction, in the path of natural vapor flow, characteristic of the converging lane principle.

Second feature is the balanced pattern of by-pass holes in the tube supports, between the similarly balanced vertical lines of tubes. Whether by the use of tube supports as diagrammatically indicated, or by other media, the intent is to remove the sectionalizing effect of tube supports and provide means to approach the full benefits accruing to parallel tube arrangement; that is, balanced natural vapor flow throughout the extent of the condensing chamber and in increased quantities toward the region of lowest temperature surface.

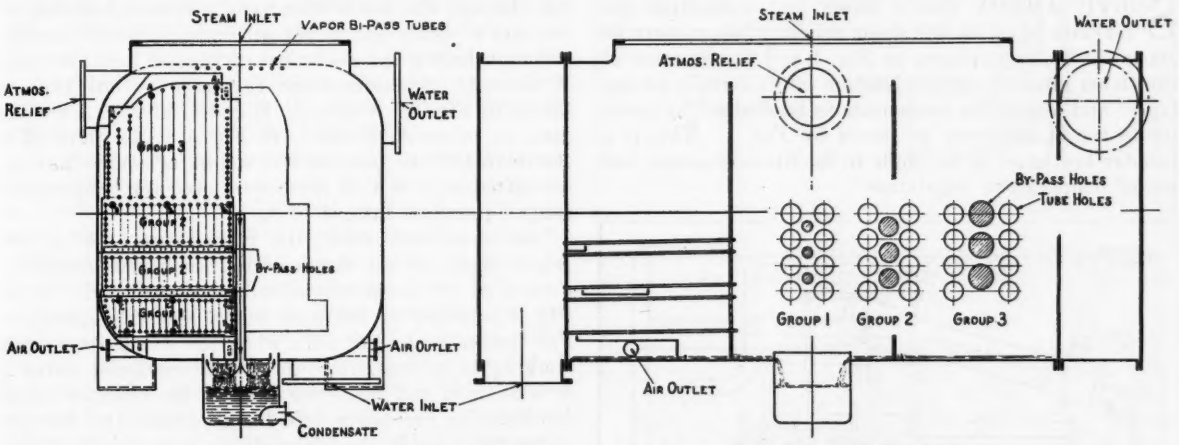
Third feature is the location of the air and non-condensable vapor header with relation to the tube bundle in general, and the final cooling tubes in particular. Extending the full width of the tube bundle, not only does it assist natural flow in balanced relation throughout the width of the tube bundle, but due to its location in the region of lowest temperature surface and lowest pressure, the only natural vapor exit terminal, it insures temperature reduction of exhaust gases to the minimum consistent with a given water temperature.

Fourth feature is the location of condensate drain

*Director Condenser Division, Alco Products, Inc., New York, N. Y. Short abstract of a very complete paper presented before the Metropolitan Section of the A. S. M. E.

plates in relation to the tube bundle in general and the final cooling tubes and non-condensable vapor header in particular. These, too, extend the full width of the tube bundle so as to preserve the balanced natural flow relation already provided for, and to remove the resistance to such flow that would result from an otherwise heavy rain of condensate over the final cooling tubes. Located as they are, these plates offer negligible resistance to natural flow in performing their important function of collecting condensate and providing for its drainage through end ports to the shell wall and center lane plates.

These four fundamental features combine to eliminate the many directional changes, turbulence and eddies affecting steam flow, and common to most of the present day types of condensers, and are believed to provide many requirements and advantages of a practical approach to ideal condensing apparatus insofar as is physically possible to obtain with surface of substantial amount, and of necessity, extending in a third dimension.



DIAGRAMMATIC VIEWS OF THE BALANCED NATURAL FLOW CONDENSER

Air and Water Circuits

In further consideration of the fact that this arrangement affords maximum dissipation of high velocity and adverse directional effect of exhaust steam within the upper, or lesser portion of the condensing surface, the condenser shown can be said to consist virtually of a number of narrow duplicate condensers, arranged for parallel operation, but without separating walls, enclosed within a common condensing chamber and so arranged as to promote natural vapor flow from a common inlet terminal, or region of highest pressure, to an exit terminal common to all condensing elements in the region of lowest potential pressure, hence the name, balanced natural flow surface condenser.

As the writer believes the condenser constitutes a step forward in the direction of the ideal concerning the vapor circuit, it is also believed that it represents a step forward in treatment of the hydraulic circuit, since an evident regard for the requirements of the former work to advantage in treatment of the latter.

For example, the saving in headroom required for the tube bundle due to the rectangular shape and therefore full utilization of the space allowed between turbine foundations, provides the space in which to place the non-condensable vapor header, and yet remain within existing limits. So with a similar header below the confines of the tube bundle introduced over the full width of the water box, a space is provided in which to dissipate entrance eddies in the water circuit.

In order to insure water filled tubes in the top of the condenser, a similar vapor header is provided above the confines of the main tube bundle. The upper portion of this header in both water boxes, requiring only the space equivalent to the total tube bowing, is connected by a number of tubes, preferably high corrosion resisting tubes, as indicated at the top of the cut. Thus, will the difference in pressure between the two water heads provide effective by-passing of air and gas around the main tube bundle thereby concentrating the corrosive effect of liberated gas on a few expensive tubes, thereby contributing to greater length of life to main condensing tubes.

The condenser is offered as a contribution in the direction of the ideal and is presented not alone for the purpose of improving condenser efficiency, but to render the collection of rational test data a feasible procedure. Not only has the vapor circuit been so treated as to promote tranquil natural flow in balanced relation between the maximum of duplicate elements arranged for parallel operation, but the hydraulic circuit has been similarly treated with a view to approaching equal flow of water through all tubes on any horizontal line, and an approach toward maintaining water at a constant density over the entire width of the water box at any horizontal line of tubes.

In other words, the liberal water header in the water box but below the bottom row of condenser tubes, provides for dissipation of eddies and removal of turbulence before water rises to contact tube ends. A similar header above the top row of tubes, provides an air bell, or vapor header which by internal venting to the discharge barometric leg, provides for by-passing liberated air around the main tube bundle. The full width of the condenser is utilized for both headers. These features combine with the balance tube arrangement to afford a practical approach to the ideal condition of water filled tubes throughout the extent of the tube bundle, constant velocity at least through tubes on any horizontal line, and water of uniform constituency at any transverse plane, and an obvious approach to sustained equality of condensing efficiency applied to all tubes on any horizontal line transverse of the tube bundle.

REHEAT — Practice, Operation *and* Control

Control of Temperature Rise in Series Steam Reheaters. Drainage and Condensate Level of Straight Steam Reheaters.

SOUTH AMBOY uses a steam and convection gas reheater in series, the steam reheater being mounted above the boiler as shown by Fig. 1 and 2. Location of the steam reheater in this position offers certain advantages[1] and allows the condensate to be drained by gravity to the boiler drum as shown by Fig. 1. This is a tubular heater set at an angle to facilitate drainage and steam temperature regulation.

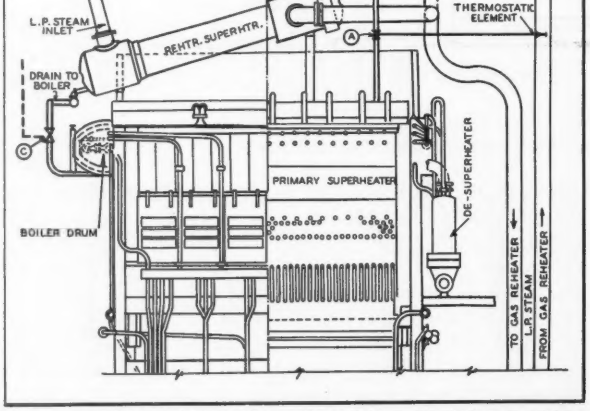


FIG. 1. STEAM REHEATER INSTALLED DIRECTLY OVER THE BOILER WHERE IT DRAINS BY GRAVITY TO THE BOILER DRUM

It is evident that with a heater of this type the reheat steam temperature can be regulated in three ways all of which are in actual use in different plants. A valve can be installed at A to limit the flow of high pressure steam to the heater as is done at South Amboy; a valve can be installed at B so some of the steam can be bypassed around the heater as at Station A; a valve can be installed at C to control the water level in the heater and give a variable heater surface as is done at Ilse[3] (on a slightly different type of heater).

Temperature Control

Control valves at any of the three locations can be made subject to automatic or thermostatic control from the temperature of the reheated steam leaving the gas section on its way to the turbine. The temperature rise through the gas section is of course a function of the rate of firing and is not subjected to direct control, although baffles, bypass or desuperheater could be used if desired. A thermostatic regulator of one type is shown in Fig. 3. Valves A, B and C of Fig. 3 are the same as valves A, B and C of Fig. 1. The drive 33 is shown in but one position but would, of course, have to be shifted to B or C if these were used for temperature control purposes instead of A.

As mentioned above the temperature rise of the reheat steam in the steam section at South Amboy is controlled by a thermostatically operated valve A of Fig. 3 actuated by the final reheat steam temperature. For instance, at light load when the steam reheater is working at its maximum, the steam regulating valve A is wide open and the water level in the reheater would be down in the lower left hand corner, the distance above the level in the boiler drum being just sufficient to balance the pressure drop in the steam line from the drum to the reheater.

As the heavy load comes on conditions change and valve A closes. The pressure in the steam reheater drops so that water is forced from the boiler drum into the reheater section. As the water level rises, covering some of the tube area, the effective heating surface is reduced and the water level tends to reach equilibrium, the exact point depending upon the relative position of the valve A; the more the valve A is closed,

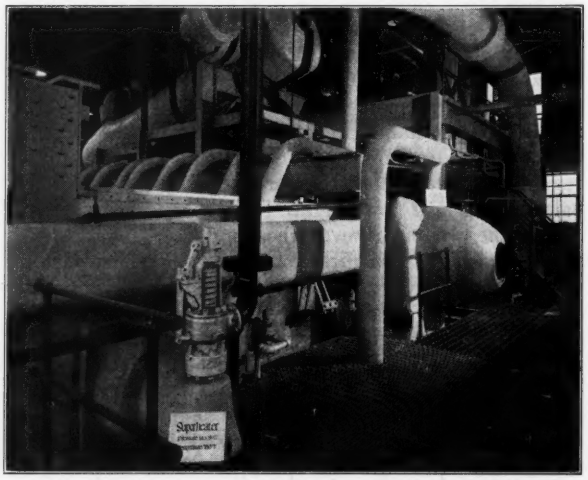


FIG. 2. STEAM REHEATER AT SOUTH AMBOY

[1] See Power Plant Engineering July 1, 1931, p. 697
[3] See Power Plant Engineering Nov. 1, 1931, p. 1058

the higher the water level in the steam reheater section. Substantially the same result is accomplished at the Ilse[3] plant by throttling the valve C, Figs. 1 and 3, to control the water level and the effective heating surface.

A section of one of the Ilse reheaters is shown by Fig. 4. This is a 1700 lb. German industrial station worthy of more than passing interest. Six of the sections shown by Fig. 4 make up the reheater. They are divided into two parallel groups of three each stacked vertically. The six drums are suspended in a framework, with the four bottom shells spring mounted to take care of expansion.

Steam to be reheated enters the bottom of the shell at 206 lb. pressure, 428 deg. F. and flows upward while the superheated steam at 1420 lb. pressure, 842 deg. F. flows downward and leaves at the bottom as condensate at a temperature of about 555 deg. F. This condensate is drained directly to an intermediate stage of the boiler feed pump at a pressure of about 1110 lb. gage. Final reheat temperature is regulated by a thermostatic valve, at C Fig. 1, to control the outflow of condensate and so regulate the effective heating surface. A check valve in the drain line prevents the back flow of water from the feed pump.

At Station A, the temperature rise in the steam section is controlled by the bypass B, Fig. 1 (this is not the Station A boiler) and dotted on Fig. 3. With saturated steam as the heating medium there is a definite maximum temperature limit which cannot be exceeded regardless of the rate of low pressure steam flow.

Steam reheaters as used alone in several stations involve an additional complication of draining unless they are installed directly over the boiler as in Fig. 1. A single boiler and turbine unit with a single steam reheater located over the boiler drum, as at Concepcion,[2] is the simplest arrangement from a control standpoint. With the exception of the steam bled, the entire flow to the throttle passes through the high pressure turbine through the reheater back to the low pressure turbine. Maximum reheat temperature is limited to the saturated

[2] See Power Plant Engineering Aug. 15, 1931, p. 840.
[4] See Power Plant Engineering Apr. 1, 1931, p. 398.

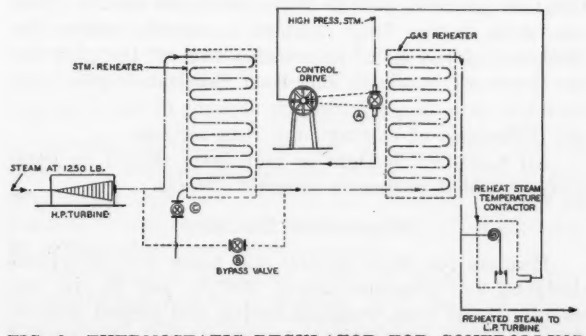


FIG. 3. THERMOSTATIC REGULATOR FOR CONTROLLING THE TEMPERATURE RISE OF THE REHEATED STEAM IN THE STEAM SECTION

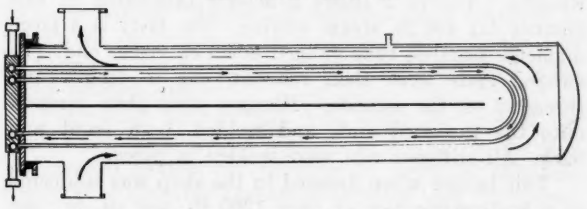


FIG. 4. SECTION OF GERMAN STEAM REHEATER

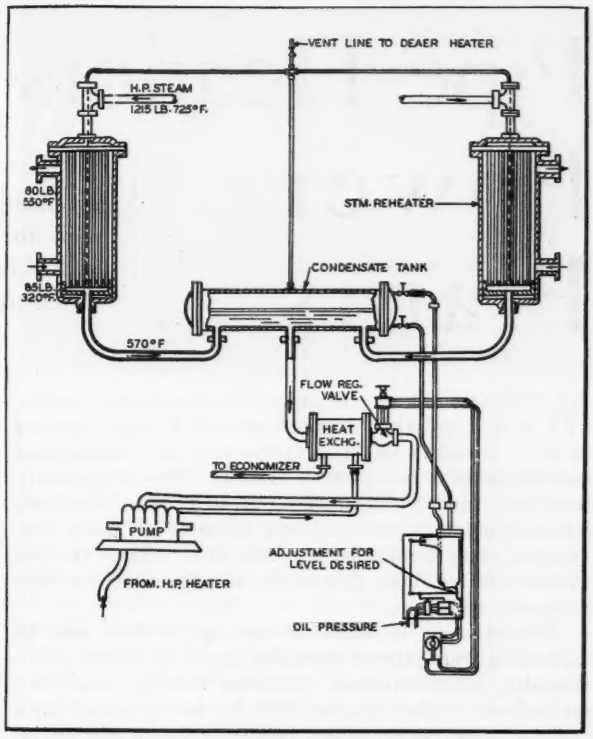


FIG. 5. STEAM REHEATER CONDENSATE LEVEL CONTROL AT RIVER ROUGE

pressure in the drum, while the actual temperature depends upon the area of the heater and the steam flow. Drains pass back to the drum by gravity.

Next in simplicity comes the steam reheater located near the turbine as at River Rouge where drainage is important. The drains may be pumped, may be drained to a lower pressure heater or to an intermediate stage of the boiler feed pump as at Ilse. In order to avoid degradation of heat head they should enter as close to the boiler as possible. With the exception of the higher pressures and temperatures, the drainage problem does not differ greatly from that of the extraction heater.[4]

Water level control of the heaters within a maximum and minimum value is advisable for two reasons: to keep them free from condensate so as to have full heating effect and to form a seal to prevent the bypass or short circuit of steam to a lower part of the system to which they are drained. A recent installation of this kind at the River Rouge plant is shown by Fig. 5. The condensate tank serves as a seal and surge tank in which the level is controlled by an oil operated flow regulating valve actuated by an automatic water level controller.

This condensate, at practically full boiler pressure, is at saturation temperature and to maintain the full heat value without the use of a separate pump it is returned to the system near the discharge of the primary boiler feed pump. The heat exchanger, supplied with water from the discharge of the boiler feed pump, cools the drains sufficiently to remove the possibility of flashing in the pump. Vent lines go to the deaerating heater operated at 28 lb. pressure. Note that the vent lines extend to the bottom of the heaters. Water level in the tank is shown by a recording instrument and this level can be changed as desired by the operator either momentarily by hand or permanently by adjustment.

POWER PLANT ENGINEERING August 1 1932

Pipe Headers Used in Power Plants

Economy and Convenience Are Prevailing Reasons for Use of Headers; Cast-Iron, Cast-Steel and Fabricated Headers Considered; Design and Installation Precautions. By Henry C. Moffett.*

WHENEVER, in the progress of a piping design, it is necessary to group several fittings together to serve branch lines, it is frequently more economical and desirable to substitute a header. This is especially true in piping systems where it is best to eliminate joints as much as possible, such as those for steam conveyance, thus minimizing the chance of leaks. On low pressure water lines, this is not as important, nor economically as sound.

Headers may be made as castings or they may be fabricated from pipe or specially forged or drawn parts. Recently, some extremely practical headers have been made from welded fittings, both for low pressure work and for pressures up to and including 600 lb. per sq. in.

Use of headers cuts down the number of flanges necessary. The saving in flanges and labor of erection quite commonly off-sets the extra cost of header construction. They also have the advantage of lighter weight, better appearance, saving of bolts and gaskets and are easier to cover.

Cast-Iron Headers

Cast-iron headers are not used as much as formerly. This is due to the fact that average pressures carried in power plants have increased and also to the fact that the art of fabrication by welding has been improved to the point that cast-iron headers are seldom of advantage.

Sometimes necessity demands the use of a special cast-iron fitting that to all intents and purposes is a header, but the reason for its employment is probably not one of economy, but of expediency. Space limitations, or obstructions frequently make such specials necessary.

In waterworks practice, or in refinery or blast furnace work, cast-iron manifolds are used at times. Usually these are for low pressure work and for distributing or assembling many lines in a limited space that would not accommodate a string of standard fittings.

As pointed out in a previous article on "Fittings", cast iron for use in headers or manifolds should be of a good quality and have a smooth grain. In order to secure a metal that will machine without difficulty, the dissolved carbon and free graphite should be properly proportioned by remelting in an air furnace or cupola. Such metal will also result in castings free from shrinkage cracks and blow holes, and will have greater strength than unrefined iron.

Cast-Steel Headers

Cast steel is quite frequently used for headers, both for medium pressure work and for pressures up to and including 1350 lb. per sq. in., with temperatures as high as 750 deg. F. Figure 1 shows a recent installation of such a high pressure cast-steel header. This header was designed for, and is withstanding a pressure of 1350 lb. per sq. in. on a high temperature steam piping system. The body of the casting is more than 4 in. thick, and the finished product weighs close to seven tons. This is about the limit for castings of this kind, as it was made of electric cast steel and there are few, if any, manufacturers that are equipped to cast more than this tonnage from electric furnaces in one mould. This limitation makes long headers impossible unless the thickness of the metal approaches that of the pipe for the pressure involved and then fabricated pipe construction is to be preferred, on account of the costs and the difficulties of casting long thin sections.

All cast-steel headers or manifolds should be carefully annealed to remove internal stresses.

Fabricated Headers

Headers for steam piping and boiler feed in plants designed for pressures above 300 lb. per sq. in. are usually made from seamless tubing and forged nozzles. There are several processes in vogue; the most general one is to form the headers by oxy-acetylene cutting and welding. Figure 2 shows a header fabricated in this manner for 400 lb. steam service. The body is a large diameter seamless tube swaged down on either end. The swaged ends were then rebored, cut to length and threaded on the outside. Flanges were then screwed onto the threaded ends and welded, both front and back. All stiffener ribs were welded in place.

This header when finished in the shop was subjected to a hydrostatic test of over 1200 lb. per sq. in. and

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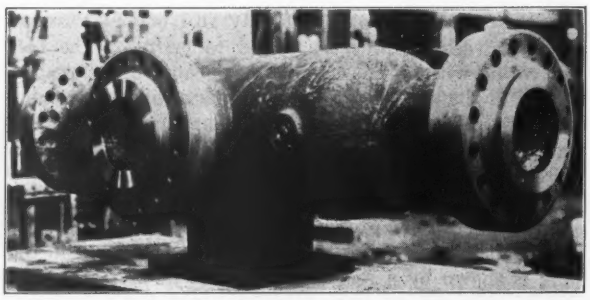


FIG. 1. CAST-STEEL HEADER DESIGNED FOR USE ON 1350-LB. STEAM LINE

that pressure maintained for one hour. No leaks or seepages occurred. It has now been in service for 5 yr., at a temperature of approximately 700 deg. F. and has given no trouble whatever.

Hammer-welding is another method used to form headers. This method has won considerable favor and is particularly adapted to headers and drums of large diameter. No welding rod is used; all welding is done by bringing the metals to the proper welding heat and then hammering them together by the use of special machinery designed for the purpose. This method has its limitations on the smaller sizes of pipe, as it becomes difficult to reach the portions that must be hammered.

Nozzles are welded onto headers by several methods, such as the butt weld, the reinforced weld, or by the method of locking the neck and pipe before welding. This last method results in a strong joint but, as it requires special facilities, it is less common.

Some manufacturers offer drop-forged nozzles of all kinds for welding onto headers or drums, and it is frequently more reasonable to use these products in the fabrication of such specials than to build up necks from pipe and flanges.

There are also on the market at the present time several kinds of welding fittings of various shapes and sizes. It is possible to build up headers for most services by welding these together, and attaching flanges or by using welding stub ends and necks.

Various other welding products are offered for use in building up headers or in fabricating entire piping systems. These are all useful in completing a job with the minimum of effort. Welding reducers and welding heads, as well as short radius pipe bends beveled for welding, make it possible to fabricate almost any kind of header for ordinary work right in the field. For higher pressures, it is well to trust such work to the fabricator who has shop facilities.

Electric welding has made rapid strides in the past few years and it is now possible to weld electrically lines which would not have been considered good practice in the past. Early welding by this method was porous and welded joints would leak under pressure, so that such welding was more or less confined to those parts not under pressure. Lines are now in existence, which have been welded throughout by arc welders and are withstanding 400 lb. steam pressure.

General Considerations

Because of the extreme size of either the cast or fabricated headers, and because every job is special and must either have new patterns and cores for castings or must be welded together from many parts, it is extremely difficult to secure accurate results.

Cast headers, first of all, must be sound and, after all machining has been finished, must be true to dimension and true to shape. Contractions of odd shapes are hard to foretell and it is sometimes necessary to try several times before the resulting product comes up to expectations. Annealing requires large furnaces in which the heating must be uniform. Even in the best of furnaces, the relieving of internal stresses will often leave headers askew.

Fabricated headers may bow along the axis of the main body when several nozzles are welded on one side and special devices are required to overcome this tendency. Straightening operations to bring back the proper alinement requires a high degree of skill.

FIG. 2 FABRICATED HEADER FOR 400 LB. 700 DEG. SERVICE

In some of the latest plants, distributing headers have been made large enough in diameter to act as reservoirs to catch the possible water that may be carried over from the steam piping or boilers in slugs. Such headers will trap the water provided the velocity of the steam coming into the manifold is not great enough to sweep it out again and on into the turbine steam chests before it has time to be trapped off. It is necessary, therefore, to provide large drains on these headers, so that the water may be carried off rapidly.

Because of the fact that most headers are true manifolds, that is, have many inlets and outlets, they are subjected to severe stresses in service. Forces may be applied in opposite directions, or at various angles by the connecting pipes. This is particularly true when several boilers are piped into a single header and take-offs to turbines or engines radiate from the same header. Operating conditions differ at different times; boilers or turbines may be shut down for repairs, and these conditions subject the headers to pulls or thrusts due to the expansion and contraction of the piping, when valves are closed or opened. It is essential, therefore, that headers be designed with large factors of safety, and further, to hang all connecting piping in such ways that unnecessary forces will not be transmitted to the headers or anchorage.

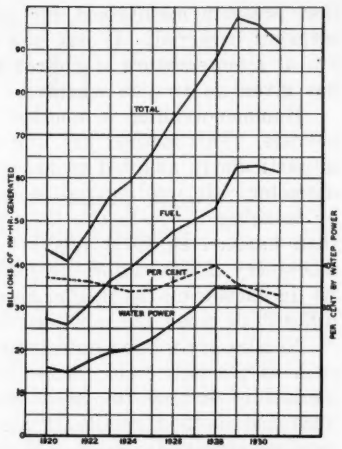
Most designers, knowing this, prefer not to anchor the main distributing header too securely, but in some fashion only limit its motion. If such motions are not limited at all, nor any guides provided to direct the motion of the pipes when expanding and contracting, there is a possibility that the entire piping system may unwind and wreck itself, especially if the pressure is high, and the temperature difference severe.

One method used successfully to take care of the condition just described, consists of the installation of a spring anchorage with limit stops. This arrangement allows the header to move laterally when the system is warmed up in starting and on cooling to take its original position without great strain.

When deciding on the kind of header to use for a given condition, it is, therefore, advisable to review all of the possibilities that may arise in service which would affect the functioning of the entire piping system to which it is attached Too much emphasis cannot be placed on the fact that headers for high pressure service should be made of the best and strongest materials available, and should be manufactured according to the latest methods of advised practice.

Trends in Electrical Power Supply*

Economies of Fuels, Types of Plants Cost of Plants and Distribution Load Planning. By Alex D. Bailey**



GROWTH OF ELECTRICITY GENERATION FROM FUELS AND WATER POWER

IMPORTANCE and stability of the electric light and power industry are indicated by the fact that during the past 2 yr. it has maintained its position of importance and has added to its reputation for economy and progress. Though it ranks thirteenth in the list of major industries in the value of its product and is in the same position regarding the number of employes, it is fifth when invested capital is considered.

Output of electricity for 1931 as estimated by the U. S. Geological Survey was 91,500,000,000 kw-hr., of which 61,500,000,000 was generated from fuels and 30,000,000,000 from water power. Compared with the previous year, as on the headpiece, this shows a decrease of 9 per cent for that generated by water power. The year 1930 compared with 1929 showed a slight increase in that portion generated from fuels, while there was a decrease of about 5 per cent for that portion generated by water power, due to extended droughts in certain parts of the country.

TABLE I GROWTH OF INVESTMENT IN CENTRAL-STATION PLANTS, TO JULY 1, 1931

Dec. 13 of Year	Water-Power Plants: Installed Capacity 1000 kw.	Water-Power Plants: Cumulative Investment $1000	Water-Power Plants: Average $ per kw.	Fuel-Using Plants: Installed Capacity 1000 kw.	Fuel-Using Plants: Cumulative Investment $1000	Fuel-Using Plants: Average $ per kw.
1920	3,850	$ 962,500	250	9,150	$1,148,500	125
1921	4,025	1,015,000	252	9,635	1,199,000	124
1922	4,150	1,079,000	260	10,750	1,300,000	121
1923	4,600	1,153,000	250	11,900	1,509,000	127
1924	5,150	1,265,000	245	13,600	1,779,000	131
1925	5,850	1,369,000	234	15,100	1,954,000	129
1926	6,096	1,416,000	232	17,032	2,143,000	126
1927	6,554	1,485,000	227	18,794	2,299,000	122
1928	7,279	1,541,000	212	19,948	2,436,000	122
1929	7,439	1,593,000	214	22,120	2,623,000	119
1930	8,207	1,711,000	208	23,843	2,799,000	117

Since 1920, up to the year 1930, as given in the headpiece, the output of electricity has shown a considerable and consistent increase from year to year. Although the reports for the last 2 yr. show a recession, the industry will maintain a reasonable growth under normal conditions, as is evidenced by the continued increase in the amount of electricity used for domestic purposes during the past 2 yr. and the expanding use of electricity in rural service.

Relative Investments in Steam and Water Power

Although the percentage of energy produced by water power has remained fairly constant at about 36 per cent of the total, the trend, for the present at least and for the following reasons, is toward a reduction in this amount: As the water power sites most readily and economically available are utilized, the cost of development of those more remote, more expensive and less reliable will make fuel-burning stations preferable because of their relatively lower cost. The initial investment for development of a water power project is usually high even though it may not be fully utilized for some time; whereas in the case of a steam station, construction can be carried on at a rate corresponding more nearly to load demands. Discovery of new and abundant reserves of cheap fuel also operates against the development of water power.

Interconnection of systems and the resultant utilization of a common reserve of generating capacity have permitted simplifications of design in fuel-burning stations which have lowered power costs. When combined investment and operating costs are considered, the thermal cycle still offers possibilities for improvement, while the efficiency of water power stations is probably as high as can ever be practically realized. Conversely, the interconnection of systems has permitted the utilization of water power which could not otherwise be economically developed because of seasonal fluctuations of water supply and high cost of water storage. Table I gives data on the relative capacities and costs of steam and hydroelectric plants.

Fuels for Steam Power Generation

Although there was a great gain in electrical output during the 5 yr. preceding 1930, the amount of coal used increased but slowly due to the improved efficiency of production. In 1930 the amount of coal used decreased, while for 1931 the amount used, as shown in Fig. 2, was less than for any previous year since 1924.

Fuel oil burned has likewise shown a marked decline during the past 2 yr., having decreased 10 per cent in

*From a paper submitted by the American Comittee to the International Electrical Congress at Paris, June, 1932.

**Superintendent of Generating Stations, Commonwealth Edison Co., Chicago.

1930 compared with the previous year and 9 per cent more in 1931. Natural gas, on the other hand, has shown a steady increase for the last 10 yr., having gained 7 per cent in 1930 over 1929 and 11 per cent in 1931.

Whereas coal constituted 85.5 per cent of the fuel used in 1929, based on heat equivalents, it was less than 83 per cent in 1931. In addition, the improvements in operating efficiency with coal made further reductions possible so that although the output of electricity generated from fuels increased fifteen times from 1902 to 1930, the coal consumption increased only four times.

Recent discoveries of extensive supplies of natural gas and the construction of large pipe lines have made this fuel a serious competitor of both oil and coal for steam stations. A significant fact is the use of natural gas from the Texas fields in one of the large stations of the Chicago district, this gas being transported a distance of 1000 mi. by pipe line and passing the rich coal fields of Illinois less than 200 mi. away.

Gas is supplanting fuel oil in certain steam stations on the Pacific Coast. Construction of new hydroelectric plants in California has practically stopped because steam stations using low priced gas and oil can be built near the load at much lower unit cost than hydro stations with their long transmission lines.

It is evident that the cost of fuels at the source is not the all-important factor, but that cost of transportation to the point of consumption for each and for electrical energy, will determine the trend in the use of various fuels and in their importance in the production of electricity.

Another item to be considered is the convenience factor, which in the case of oil or gas effects considerable savings in station investment and operating costs as compared with coal. This convenience factor, so called for want of a better name, may even be an influence outside the station itself because of the recent interest of the public in air pollution due to smoke, dust and fumes from the stacks of coal-burning industries. Evidently we shall be dependent primarily on fuels for the production of electrical energy, at least until present methods of production have been superseded, hence the choice of fuels and their relative importance will continue to be an interesting and absorbing study.

Recent Developments

Outstanding features in the recent development of the electric utilities have been: Centralization of power

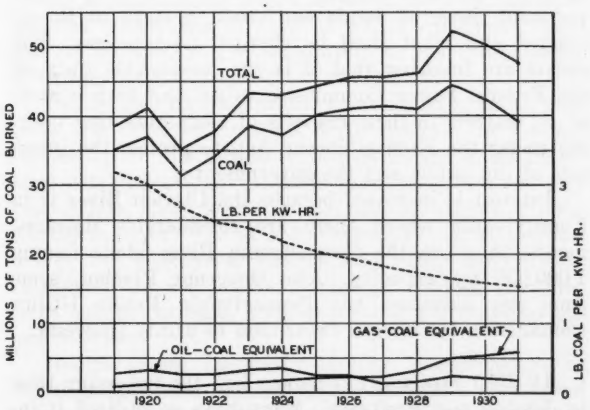


FIG. 2. CHANGES IN FUEL CONSUMPTION OF ELECTRIC PLANTS

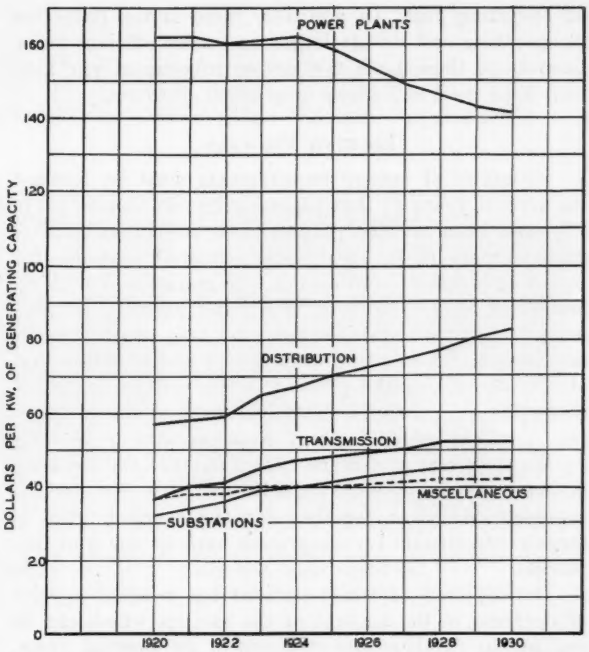


FIG. 3. CHANGES IN PLANT AND DISTRIBUTION SYSTEM COSTS

production; interconnection of large systems; extension of service into sparsely settled and rural communities; and the continued reductions in rates to users of the service. The first two features have resulted in decreased investment and operating costs without decreasing the reliability and quality of the service; also, through interconnection, the development of certain water power sites has been made economically possible because of the steam reserve which has thus been made available.

Because of the high ratio of invested capital to income the amount of investment per unit of electrical capacity must receive the greatest attention. At the present time, this ratio is 5.64 for the entire industry, which means that the annual income is less than one-fifth of the invested capital, as compared with income of several times the invested capital in certain other industries. Recent analysis, shown in Fig. 3, indicates that the average capital invested for the complete electrical system per kilowatt of generating capacity is steadily increasing, the investment necessary for substations, transmission lines and distribution systems having grown at the rate of 20 per cent in the last 10 yr. while, the unit cost of the power plant alone, which at present represents only 39 per cent of the total cost, has decreased only 13 per cent during the same period.

Transmission costs have grown as a result of the centralization of power generation and distribution costs have increased because of improvements in the service and extension of the service into more scattered territory. Consideration of growing total unit costs is necessary; if the cost of large stations and their attendant transmission systems and substations is greater than the cost of smaller decentralized stations at the load, the difference in fixed charges must be more than offset by improved capacity factor and reduction in operating expense.

Improvement in capacity factor reduces the fixed charges per unit generated and also has a similar effect

on operating cost. In addition, there is the reduction in operating cost due to larger and more efficient units. Because of these facts the system investment per kilowatt-hour sold has shown a gradual decrease.

Looking Forward

Estimates of energy requirements must be forecast for several years so that plant equipment can be properly and economically planned and provided. Studies must be made of fuel and water resources available for power production; contact must be maintained with all associated developments at home and abroad; research must be instituted to determine not only improvements and refinements in plant construction and operation but also new uses for the product or the extension or improvement of present utilization. Much of this pioneering work has been done and must continue to be done by the electrical producers. The fact that the industry is non-competitive within itself and that the various organizations work together for the common good is largely responsible for its growth both in size and usefulness.

Development of steam stations has reached a point of decrease in the amount of the savings which can be realized by further improvements in the thermal cycle; hence the effect of load factor gains in importance. Much attention and study must be given to the operating problems of such systems, whether depending upon steam plants alone or combined with water power, in order to secure economical operation and to render satisfactory service. While the increment unit production costs are relatively small, so far as final costs are concerned, the great output turns small gains into large amounts in the aggregate, justifying extended and detailed studies and surveillance if power is to be produced at lowest cost.

Operating Considerations

Operating procedure has been quite definitely established by each organization. Studies of steam plant performance have been made for each installation and each generating unit so that the overall effects of load factor and capacity factor are accurately determined. Load variations, both daily and seasonal are determined in advance from estimates of output and load curves are prepared for most economical distribution of output for any given load, having in mind the service, operating cost, operating reserve and other important items of operating procedure.

Station and even unit loads can be scheduled so that the operators can follow the loading schedule and adjust the output of their respective stations to suit load conditions. In addition, with the output forecast and the resulting load curves laid out, it is possible to estimate operating efficiencies and costs in advance with considerable accuracy, to predict fuel requirements month by month and to plan the loading of transmission systems.

Operation of systems and of individual stations in emergency, occasioned either by failure of equipment or by sudden and unexpected load changes can likewise be planned in advance. Troubles which are anticipated can be eliminated or their effect considerably reduced, if proper instruments are installed so that each case of trouble can be readily located and identified.

In an effort to reduce the personal element and to get better control, use of automatic equipment has shown a marked increase, partly for protection and partly for normal operation. While these devices have, in a measure relieved the operators of considerable detail and while there may be a tendency to emphasize and even overdo automatic operation, the importance and responsibility of the individual has probably been increased. Intelligent, highly-trained men are now required as station operators.

Service Cost

Electric utilities service covers more than the mere supplying of electric energy for light, heat and power; the ramifications of the service have become so great that the station production cost is no longer a measure of the cost of rendering service, as it is commonly understood.

Although the coal equivalent of all the fuel used for the production of electricity in 1930 was approximately 50,000,000 t. of 2000 lb., the fuel cost per kilowatt-hour represented only about 6 per cent of the domestic customer's bill and, in the case of energy generated from water power, this item was entirely missing. The cost of fuel is exceeded by that of keeping the domestic customer's account and rendering his bill, while the cost of reading his meter is about two-thirds as much as the cost of fuel. These are, of course, only a few of the details of the service cost.

Water Power Control Decision

By A. P. Connor, Special Washington Correspondent

In the Case of Clarion River Power Co. of Pennsylvania, the Court of Appeals of the District of Columbia has rendered a decision which is final unless taken to the Supreme Court of the United States, which will probably be done in this case, as the decision is far reaching in results.

Some points involved are that sites granted to utilities for water power are, when under Federal jurisdiction, a privilege from the sovereign state justified only on the basis of benefit to inure to the public. This is taken to mean that, if there is an overstepping of rights by the organizers of water power developments, governmental departments are called on to retrieve the rights of the public. Decisions are building into a formidable wall that may place utilities using water powers under Federal jurisdiction as to amount of investment, issue of bonds and stock, moneys to be expended and what shall be charged as expenses. The courts are insisting that it is the inescapable duty of the Federal Power Commission to get and keep control of all matters in these respects of companies that operate under the Federal Power Act, to protect the interests of the public and the government.

Interest is increased because the Clarion River is in Pennsylvania where there are considerable developments, those on the Susquehanna River alone having 1,000,000 hp. capacity. Also Governor Pinchot, some time ago dismissed the Pennsylvania Public Utility Commission for alleged favoritism to utility interests.

In 1931 the manufacturer had the necessary time to develop new products. Many have so utilized it instead of "resting".—Chemical Digest.

Power Utilization

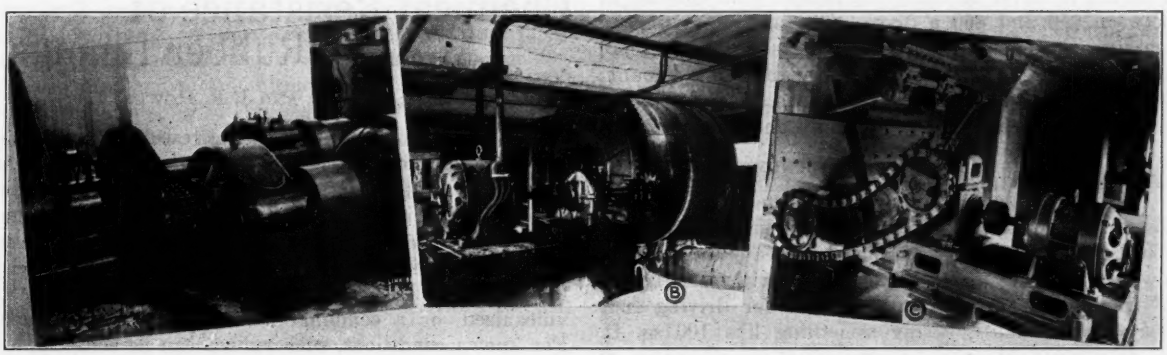


Fig. 1. Link-Belt 150-hp. reducer and roller chain drive for plate-bending roll.

Fig. 2. Palmer-Bee speed reducer on pebble mill paint grinding.

Fig. 3. Cleveland worm and gear drive for rock feed from storage bin.

Lower Production Costs with Modern Speed Reducers

RELIABILITY, COMPACTNESS OF DRIVE AND INCREASED CAPACITY SECURED. BY REGINALD TRAUTSCHOLD

WHILE low-cost power is highly desirable, power cannot be generated or purchased at a rate sufficiently low to justify its being dissipated recklessly. During the past decade, the betterment in utilization of fuel in power generation has probably been, in outstanding instances, between 40 and 45 per cent, although, in the average plant, the record is far less impressive.

Such improvements pay, unquestionably, and well justify the plant investments needed to bring them about but, in the average plant, economies of like and often much higher order may be secured in the field of power utilization with relatively small expenditure. Power utilization involves a series of more or less independent operations in each of which equipment units are employed that are susceptible of more economical operation.

Better bearings, simplified transmissions, better controls and other refinements make possible the present realization of worthwhile economies in almost all industrial establishments. In some cases, preconceived misconceptions alone stand in the way of effecting noteworthy savings. The idea, for example, that mechanical drives for conveyors, stokers and other heavy duty equipment do not justify the use of efficient transmissions has, in the past, been responsible for quite serious power losses.

Rough gears, inefficient belting, complications of shafting frequently entail the use of costly slow-speed power units, not conducive to economy in the utilization of power. Compact, self-contained gear assemblages and modern speed reducer units can usually be employed to great advantage, giving more efficient use of power and greater dependability and often at actually less first cost.

PUMPING OPERATIONS IMPROVED

Where, as in a paper mill, pumping processes are important in production activities, dependability of operation and the saving of time in connection with the installation of the equipment may have high value. A case in point is the marked improvement in stock pump operations at the A. P. W. Paper Co., Albany, N. Y., first by the substitution of an ordinary pinion and gear drive for a poorly designed belt transmission and later by the application of a modern speed reducer unit.

Stock pumps in question are located in a damp basement and the belts as used at first would stretch and slip, seriously interfering with the constancy and uniformity of the stock supply to the paper machines. Obviously, this situation called for a dependable positive type drive and simple gear trains, consisting of two large gears and two fibre pinions, were installed. This substitution effected a considerable improvement, the positive nature of the drive assuring a suitable feeding of stock to the paper machines. But the heavy duty of pumping the preparation, 24 hr. a day under trying conditions caused the fibre pinions to wear rapidly, necessitating frequent replacement.

Worm gear speed reducer units were then tried and proved not only much more reliable but considerably

cheaper. These highly efficient units actually cost less than the simple gear trains previously employed and were installed more easily and more rapidly. Where one speed reducer drive was installed by a man and helper in 12 hr., installing the open gearing took 96 man-hours, four times as long. This alone represented a saving in favor of the speed reducer transmission of between $50 and $60 a drive. The annual savings in maintenance expenses were also in favor of the more efficient assemblage by substantially the same amount; for the average life of the fibre pinions, costing installed close to $18 each, proved to be only about 8 mo.

Pebble Mill Drive Economies

Much the same experience is reported by the Eagle Pencil Co. of New York, where a number of modern speed reducer units are employed in heavy-duty drives. Two of these advanced transmissions, with speed ratios of as high as 30 to 1 are employed for driving four heavy pebble mills, saving something like 100 sq. ft. of valuable floor space, appraised at yearly value of $165. At the same time, these drives virtually assure continuous mill service, so desirable in holding down manufacturing expenses.

Each of the speed reducers cost $650 installed, while the operating expenses for lubrication and labor amount to less than $12 a year. Annual fixed charges, including suitable provisions for repair and maintenance expenses, total $83 to $84, placing the net operating cost per mill at less than $1.00 a week. Furthermore, all overhead shafting has been eliminated; the drives are relatively quiet and no special guards have to be provided to protect the machines.

Improved Fan Drive

Less arduous but nevertheless exacting, is the speed-reducer drive of a forced draft fan that contributes materially to the economical operation of the Lynn Gas and Electric Co. power plant. Formerly, this large fan was driven by a vertical steam engine but, as the load on the central station increased, it was found that the engine had to labor more and more to carry the necessary combustion air load, with the result that its steam consumption became excessive. A steam turbine, coupled to the fan through a modern speed reducer unit, was then installed and, in four years of continuous operation, the only upkeep expense on the speed-reducer unit was for a set of two bearings.

Net yearly saving of $5,475 was effected in steam consumption alone by the new arrangement. The speed-reducer unit, which cost installed $1,315, uses only about 15 quarts of oil a year and imposes virtually no other expense. Taking into account all fixed and operating expenses chargeable to the gear unit, including ample allowances for repair and maintenance, gives the net cost of operating the forced draft fan as less than $185 a year, in fact, or about 50 cents a day.

These quite common applications of modern speed-reducer units are nothing unusual and there is an abundance of confirming evidence regarding marked savings in hundreds of other establishments. They do illustrate, however, simple methods of cutting costs and effecting substantial savings in the utilization of power. Speed-reducer units are available for heavy as well as light service drives, frequently at lower investment cost than for cumbersome and much less efficient makeshift drives. Reliability of equipment operation is secured, space conserved and equipment capacity often increased, all important gains of a permanent character that are reflected in lower manufacturing expenses. They pay, moreover, whether power is cheap or dear.

Chemical Resistance of Rubber Linings*

By H. E. Fritz and J. R. Hower**

VALUE of rubber as a chemical resistant depends on chemical inertia, physical properties and intelligent combination with other materials. Compounds are designed for specific uses and can be bonded to other materials so as practically to become integral with them. Unvulcanized rubbers have been used to a limited extent but the bulk of rubber used in chemical service is vulcanized, or a combination of soft and vulcanized. For known conditions, such rubber can be compounded to resist long time submersion in inorganic acids, salts or alkalies and to some extent in organic materials such as less active acids, acetone, various alcohols, some vegetable oils and fruit juices.

For most materials 150 deg. F. is the maximum temperature with a few of the more chemically active limited to 100 deg., as oxidation, diffusion and absorption are aggravated at higher temperatures so that life of the rubber is materially shortened. When long life is a minor consideration, exposure to chemicals is intermittent or contamination of the product handled is not a serious matter, soft rubber or higher temperatures may be and often are used.

Curiously, pure water, especially at high temperatures, affects rubber more than do most of the chemicals handled, molecular diffusion causing a swelling of soft rubber and the dissolved oxygen hastening deterioration. Oils produce a like effect. Hard rubber is much better to resist the absorption and swelling.

Hard vs. Soft Rubber

Vulcanized rubber, chiefly sulphur and rubber has its resistance increased as the sulphur content is made larger. If vulcanizing is carried to the hard rubber stage, rigidity is greater, machining is easier, electrical resistance is increased, but at the sacrifice of the elasticity, resilience and resistance to abrasion of the soft vulcanized material.

Hard rubber has some 3 to 5 times the expansion of steel between 32 and 140 deg. F., which entails difficulties with rapid temperature changes; also, at below 32 deg. F. hard rubber is brittle and easily cracked.

For lining tanks, it is, therefore, desirable to use a combination of a layer of hard rubber cushioned between layers of soft rubber, the hard rubber overlapping but not touching at the joints and imbedded in the soft rubber, thus giving freedom for expansion and contraction. Such a lining can be bonded during the vulcanizing process to steel and some other materials for lining tanks, pipes and vessels used in process work or chemical industries. Relative thickness of the layers can be varied according to requirements for non-absorption and expansion.

*From a paper before American Society for Testing Materials.
**Manager and Assistant Manager, Chemical Sales Div., B. F. Goodrich Co.

Insulation Linings

For some processes, where liquids at higher temperature, say up to 250 deg. F. are used, an insulating lining is placed to protect the rubber lining. Brick 4 to 8 in. thick has proved satisfactory, the temperature drop through 4-in. brick being from 212 deg. down to 153 deg. F., through the rubber lining from 153 deg. to 148 deg. and through the ¼-in. steel wall from 148 deg. to 70 deg. Such construction is used for pickling tanks and to handle such materials as ferric and zinc chlorides, ferrous, zinc and nickel sulphates and other highly corrosive materials, up to 250 deg. F. Where temperature is 150 deg. or less, wood sheathing may be used instead of the brick lining as physical protection for the rubber.

Applications

For use in industry it is of utmost importance that correct type of compound and design of equipment be chosen, a safe policy being to collaborate with manufacturers who have adequate technical facilities for test and experiment.

Major applications in chemical service are:

1. Linings for tanks and tank cars, drums, pumps, piping, valves and fittings. Steel surfaces are usually sand-blasted, special adhesive applied, unvulcanized sheet put in place and vulcanized by steam or boiling water at 20 to 60 lb. pressure. Adhesion of lining to steel can be made 500 lb. per sq. in. or more.
2. Transmission and conveyor belts.
3. Gaskets and packing for pipe lines and tanks, varying from pure rubber to high percentages of asbestos or other minerals, depending on the material to be handled.
4. Hose, tubing and molded parts for processing work, of soft to hard rubber according to conditions to be met.
5. Protective clothing such as shoes, gloves and aprons, of soft rubber.
6. Sheet rubber for linings, blankets, flooring and the like.

For any use, service conditions and requirements should be accurately defined and close coöperation should be secured between rubber user and rubber maker to get best results.

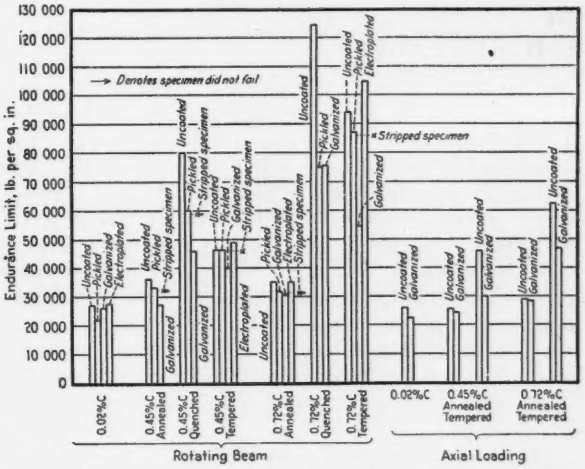
Effect of Zinc Coatings on Steel

Effect of Surface Alterations resulting from the application and presence of hot-dipped galvanized and electroplated zinc coatings on the endurance properties of open hearth iron and 0.45 per cent and 0.72 per cent carbon steel was determined by fatigue tests made with a Moore rotating beam and Haigh axial loading machines. Results of these tests were recorded by W. H. Swanger and R. D. France of the Bureau of Standards in a paper presented at the 35th Annual meeting of the A.S.T.M.

Rotating-beam tests were made on: polished but uncoated specimens; specimens coated by the hot-dip galvanizing process; zinc-plated specimens; and on specimens acid pickled as for galvanizing. Axial loading tests were made on uncoated and galvanized specimens only. The open-hearth iron was tested in the as-rolled condition. The two carbon steels were tested in the normalized and annealed condition, in the quench condition and in the tempered condition, except that axial loading tests were not made on quenched specimens.

Endurance ratios (endurance limit to tensile strength) by the rotating-beam method of test of the uncoated specimens varied from 0.38 to 0.70; by the axial loading method, from 0.31 to 0.59. The decrease in endurance limit from that of the polished, uncoated materials caused by the acid pickling was more marked in the quenched steels than in the annealed and the tempered steels. The decrease varied from 0 to 40 per cent.

A still greater decrease, as much as 42.5 per cent, was caused by the presence of the hot-dipped galvanized



ENDURANCE LIMITS DETERMINATION TO SHOW THE EFFECT OF ZINC COATINGS ON 0.45 AND 0.72 PER CENT CARBON STEELS IN THE ANNEALED, QUENCHED AND TEMPERED CONDITIONS

coatings. The quenched and the tempered steels were affected more adversely than the annealed steels. Endurance limits of the zinc electroplated specimens were equal to or greater than those of the uncoated specimens.

Difference in the effects of the two types of coating is believed to be caused by the differences in the nature of the bond between zinc and the steel and the structure and hardness of the two coatings.

Motor Oil Guard

Best form of guard to prevent oil and grease being thrown from a chain and sprocket into the motor is largely a matter of experience. In my own work, I have found an enclosed metal case completely housing the chain and sprocket to be the most effective. It also provides an excellent safety device. By means of doors in the gear case which may be located conveniently to the sprocket, the chain can be easily inspected and lubricated.

Edward W. Johnston.

In the plant of Buda Mfg. Co. at Harvey, Ill., old water-tube boilers and stokers were replaced by a 778-hp. B. & W. cross drum boiler to burn pulverized coal. Furnace bottom is hopper shaped of two banks of water tubes with Bailey smooth faced blocks. Air, preheated to 400 deg. F., is fed to the ball mill pulverizers whence fuel is drawn by exhausters and forced to the burners. Fuel was changed from No. 2 southern Illinois nut to carbon; the evaporation increased from 7 pounds to 9½ lb. with efficiency 82 to 84 per cent. Saving of $38,000 a year is reported.

POWER PLANT ENGINEERING August 1 1932

Parallel Operation of A. C. Generators

Part VII. Phase shifting to compensate for differing voltage angles in power circuits

By
E. H. STIVENDER

IN SOME installations it occurs that synchronizing must be done from potential transformers which are separated by Y— delta connected power transformers as well as oil switches. As has been explained, it is necessary to connect one side of large 3-phase banks of power transformers in delta in order to permit the flow of higher harmonics of magnetizing current. Since a grounded neutral is desirable on high tension transmission lines owing to certain economies in insulation and the allowance offered for accurately setting protective relays by predetermined calculations, a general practice is to connect the low tension side delta and the high tension side Y.

Figure 1 illustrates a condition where the economies of using available, less expensive low tension potential transformers in preference to extra high tension transformers is manifest. An arrangement of this kind requires some form of phase shifting connection, one type being shown in Fig. 1.

In order to provide a method illustrating the e.m.f. relations of other methods described later the generator will be assumed as being Y connected and the vector diagram, Fig. 1 (A), is drawn incorporating the phase relations within the generator as well as those within the transformers.

Vectors OA_1, OB_1 and OC_1 represent the phase e.m.f.'s of the generator, and then the voltage at the generator terminal is:

$$-OA_1 + OB_1 = A_1B_1$$
$$-OB_1 + OC_1 = B_1C_1$$
$$-OC_1 + OA_1 = C_1A_1$$

These voltages are also those at the transformer secondary terminals. The transformer being connected Y — delta, the high tension e.m.f.'s will be:

$$-A_1B_1 + B_1C_1 = A_2B_2$$
$$-B_1C_1 + C_1A_1 = B_2C_2$$
$$-C_1A_1 + A_1B_1 = C_2A_2.$$

Since the auxiliary transformers are connected delta-delta, to provide for a possible emergency connection of open-delta in case of failure of one single phase unit, the secondary terminal voltages A_3B_3, B_3C_3 and C_3A_3 of the auxiliary bank are in phase with the primary voltages A_2B_2, B_2C_2 and C_2A_2, hence potential transformers connected to the secondaries of the auxiliary transformers will produce secondary voltages of the same phase relations as ones which might be placed on the high-tension bus. By using these transformers for synchronizing, the need of additional high tension potential transformers is offset.

In Fig. 1 (A) voltages A_2B_2, B_2C_2, C_2A_2 and A_3B_3, B_3C_3, C_3A_3 are represented by the same respective vectors. The generator voltages A_1B_1 etc. are 30 degrees out of phase with the high tension and auxiliary bus voltages, therefore in order to obtain correct indications on a synchroscope, this phase angle must be compensated for in the potential secondary circuit or eliminated by using special potential transformers between line and neutral in the power circuit.

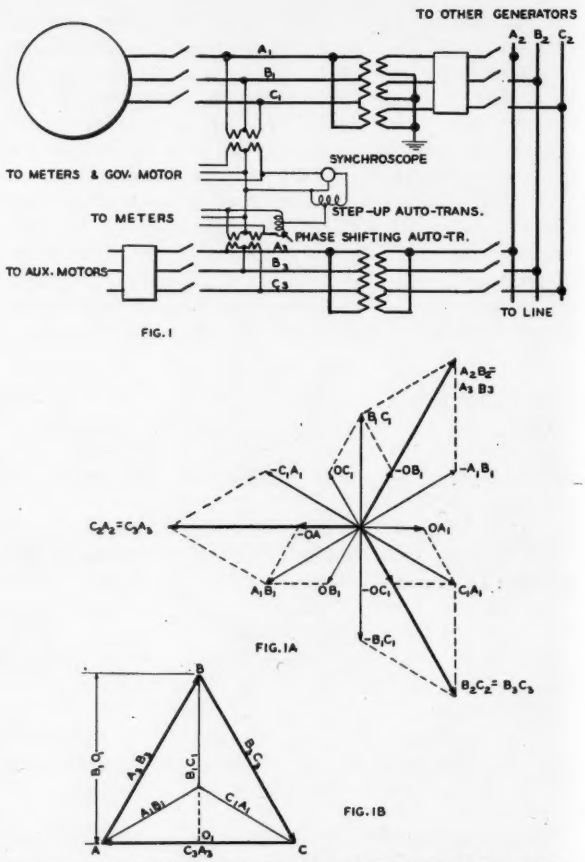


FIG. 1. A CIRCUIT WHERE A PHASE SHIFTING AUTO-TRANSFORMER IS USED

(1A) Voltage relations of the complete power circuit.
(1B) Vector B_1 O_1 represents the relative voltage value and phase relation of voltage B_1 O_1 in the synchronizing circuit.

A generally used method of shifting the phase angle is that illustrated in Fig. 1. A small 2:1 ratio auto-transformer is placed between lines A_3 and C_3 of the auxiliary bus potential transformers, one element of the synchroscope being energized from the center tap O_1 of this auto-transformer to phase wire B_3. The other element of the synchroscope is energized directly from lines C_1 and B_1, B_1 and B_3 being connected together through a common ground bus.

The vector relations for this connection are given in Fig. 1 (B). Vector C_3A_3 is the vector difference between A_1B_1 and C_1A_1, similarly the other phases are drawn in. Then a line drawn from the center point O_1 of C_3A_3 to the junction point B represents the voltage between points O_1 and B_3 in Fig. 1. It is now noticeable that vector O_1B coincides with B_1C_1 and the syncroscope will indicate synchronism, even though the generator terminal voltages are 30 degrees out of phase with the high tension bus voltages.

Since vector O_1B is only 86.6 per cent of the value of C_3A_3, when the normal potential secondary voltage is 110, voltage O_1B_3 is 95.26 volts; hence in order to make the synchronizing lamps indicate correctly a small 0.866/1 step-up auto-transformer is sometimes placed in circuit.

Use of Voltages to Neutral

There are other methods of phase shifting which may be used to obtain the desired conditions for synchronizing across Y—delta transformers but they generally posses more disadvantages. In Fig. 1 it is noticed that the generator potential transformer secondaries supply power for the governor flyball motor. In the hydro-electric installations where the governor ball head

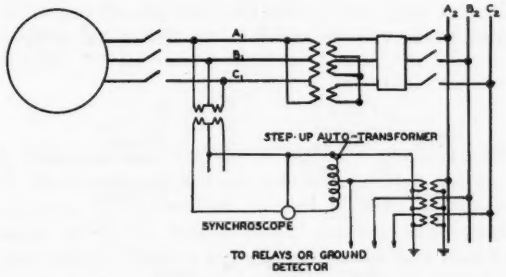


FIG. 2. ILLUSTRATING THE POSSIBILITY OF USING THE VOLTAGES PRESENT IN CERTAIN INSTALLATIONS. IT HAS PRACTICALLY NO ADVANTAGE OVER THAT OF FIG. 1

is driven by a small three phase induction motor, and this motor is Y-connected, the voltage to neutral may be utilized for synchronizing. This motor when used is often not connected to the same potential transformers as those furnished for metering, as is shown in Fig. 2, but is connected to separate transformers similarly connected.

In the vector diagram of Fig. 1(A), OA_1, OB_1 and OC_1 represent the phase voltages of the motor as well as the generator. Now it is noticed that vector A_2B_2 is in phase with $-OB_1$, hence one element of the synchroscope may be energized from line B_1 to neutral of the governor motor and the other element by phase A_2B_2 of the bus, or its equivalent, phase A_3B_3.

A connection of this kind is not recommended for permanent operation, since it is generally considered unwise to place the load of any other circuit on the governor fly-ball motor windings or leads supplying them. Another objectionable feature which exists is that the voltage to neutral of the motor is only 57.7 per cent of potential secondary voltage, that is on 110 v. circuits this voltage is 63.47 v., which will not be sufficient in some cases unless a small 0.577:1 auto-transformer is placed in the synchroscope circuit.

Use of Available Specially Connected Potential Transformers

The use of a special phase shifting auto-transformer can be dispensed with in instances where specially connected potential transformers installed for other purposes are available. Some relays, such as impedance relays for grounded phase protection and reverse power relays used under certain conditions, require a Y — Y connection of potential transformers. In Fig. 2 is illustrated such a connection; the synchroscope may be energized between A_2 and neutral of the bus potential transformers and A_1 and B_1 of the generator potential transformers. In order to obtain equal voltages for synchronizing, a 0.577/1 step-up auto-transformer should be placed in the synchroscope circuit.

Where special types of high speed voltage regulators are used, a potential transformer connection known as the positive phase sequence network is sometimes employed. The opportunity of using the 30 deg. angle present between some of the secondary voltages may be taken advantage of. In Fig. 3 is illustrated a circuit where the synchroscope is connected to A_2 and B_2 of the bus single phase potential transformer, and between A'_1 and B'_1 of the secondaries of the regulator potential transformers.

The vector diagram, Fig. 3(A), illustrates the voltage conditions present in the circuit of Fig. 3. In the regulator potential transformer circuit, A_1B_1 of the primary is in phase with A'_1O of the secondary. OB'_1 is reversed in direction to B_1C_1. Then $-A_1B_1 + B_1C_1$ equals $A'_1B'_1$; it is noticeable that this vector is 30 deg. from A_1B_1.

Vector A_2B_2 is derived in the same manner as in Fig. 1(A) and is in phase with $A'_1B'_1$, hence the synchroscope will indicate correctly when energized from $A'_1B'_1$ and A_2B_2. Since the resultant voltage of the regulator transformer secondaries is 173.2 per cent of secondary voltage, a step-down auto-transformer must be placed in circuit, in order to protect the coils of the synchroscope.

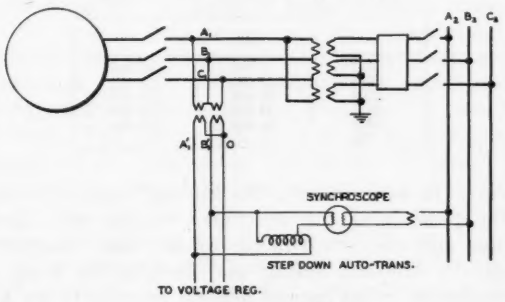


FIG. 3

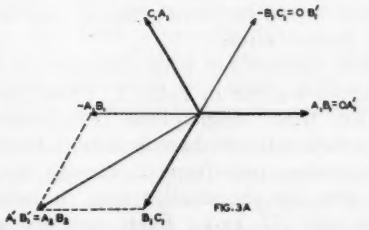


FIG. 3. ANOTHER POSSIBLE CONNECTION FOR SYNCHRONIZING BUT WHICH IS INFERIOR TO THAT OF FIG. 1

In all, wherever conditions permit it is preferable to employ a phase shifting auto-transformer as in Fig. 1, since as a rule interconnections with important isolated circuits, such as voltage regulators, are eliminated and the synchronizing and metering circuit is more of an independent unit. The use of step-up and step-down auto-transformers is in most cases unnecessary in Fig. 1, however the complete unit of phase shifter with step-up 0.866/1 auto-transformer may be purchased in a compact box as part of the switchboard equipment.

Why Transformers Are Rated in Kv-a.

TRANSFORMERS, USUALLY, are rated on the basis of kilovolt-amperes rather than the kilowatt output. This is done because in rating a transformer, the question of power factor is involved. In considering the rating of a particular transformer, uncertainty would exist about its kilowatt rating—even if the normal voltage and current values were known—until the power-factors were known under which the unit was to operate. In other words, the kilowatt output is equal to the product of the secondary voltage and current ratings and the power-factor of the load. Instead of using the kilowatt rating and keeping in mind the power-factor, it has become general practice to use kv-a, which is the product of the voltage and current. The kv-a rating equals the kilowatt rating only when the power-factor is 100 per cent; that is, kilowatt capacity is kv-a $\times$ power-factor.

TABLE I. KV-A RATINGS OF DISTRIBUTION TRANSFORMERS

Single Phase	Three Phase	Single Phase	Three Phase
1.5	....	150	450
2.5	....	200	600
3	....	250	750
....	5	333	1000
....	7.5	400	1200
....	10	500	1500
5	15	667	2000
7.5	....	833	2500
10	....	1000	3000
15	....	1250	2750
....	25	1667	5000
....	37.5	2000	6000
....	50	2500	7500
25	75	3333	10 000
37.5	....	4000	12 000
....	100	5000	15 000
50	150	6667	20 000
75	....	8333	25 000
100	300	10 000	20 000

TABLE II. SYSTEM VOLTAGES

Volts		
440	13 200	88 000
550	22 000	110 000
2300	33 000	132 000
4600	44 000	154 000
6600	66 000	222 000
11 000		

Accepted ratings for both distribution and power transformers are given in Table I. From this table it is evident that three single-phase transformers can be grouped to form a three-phase bank with the same rating as the three-phase transformer. Though this is not exactly the case for the smaller sizes, it holds true for those sizes over 75 kv-a. Each standard size in the smaller three-phase ratings can be used to operate a standard motor; and in general the ratings cover the whole range, with the same percentage increase from one size to another.

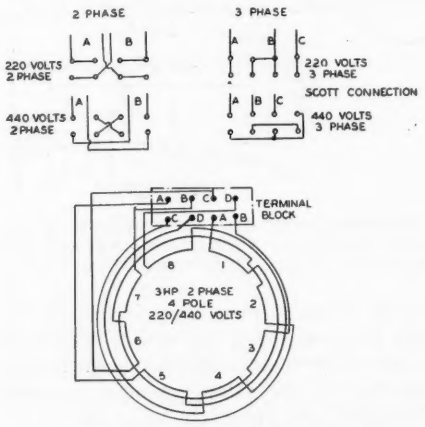
The standard system-voltage ratings upon which transformers are required to operate are shown in Table II. Voltages of 440, 550, 2300, 6600, 11,000, and 13,200 volts are originally generator voltages. Voltages of 22,000 volts and higher are ordinarily secured by stepping up the generator voltages before transmission. Transformers operating on these system voltages will operate satisfactorily on voltages, say, five per cent higher than the standard.—ELECTRIC JOURNAL.

An Unusual Motor Connection

By GRADY H. EMERSON

SEVERAL YEARS ago, I ran across an unusual motor connection in that it could be changed to two different voltages in two different phases. This was unusual because of the fact that the necessary conductors were brought out to a terminal block. There were no instructions with the motor however and only an electrician familiar with motors could make the necessary changes.

The nameplate reading indicated that the motor was designed for two-phase operation on both 220 and 440 v. It delivered 3 hp. at 1800 r.p.m. The leads brought out for the purpose of changing the voltage from 220 to 440—2 phase also answered for a Scott connection when changing from 2-phase to 3. There were eight of these leads and they were paralleled or placed in series according to the voltage on which the motor was to operate



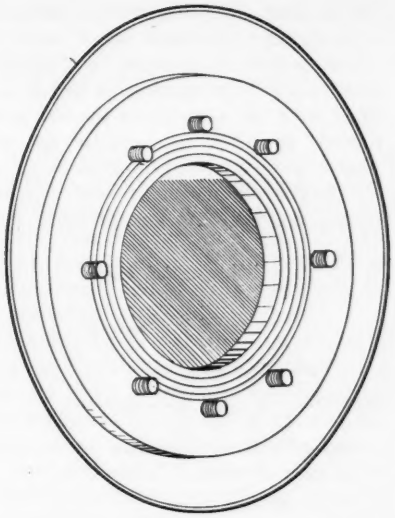
A VERSATILE MOTOR CONNECTION

The purchaser of the motor had bought it with the understanding that it was a 3-phase motor but when he had connected it to a 3-phase, 220-v. line it would not run. He called for outside help and we found, after checking the nameplate, that it was 2-phase. The purchaser wanted to know whether we couldn't make it run on 3-phase, I assured him that this was possible but with a loss of power and efficiency. Also abnormal heating would result. The horsepower would have to be cut to about 2.5 but if the load was not over this, he could probably use it. The motor was belted to a small shear and was used only intermittently, so we decided to make the change. As the leads were not marked, we removed the motor head and traced out the leads and marked them as is shown on the sketch. Then it was only a matter of minutes to connect the motor for Scott method. This method is not recommended for a suitable change if the motor is used for continuous duty.

It is seldom that a motor as small as this is arranged for changing voltages and if the connection had been a top to top instead of a top to bottom, considerable more changing would have been necessary to make the motor operate on 3-phase. The sketch shows the four possible connections for the two phases.

OIL CIRCUIT breakers for 230 kv. are now available which, including time for relay action, will interrupt short circuits in 0.2 sec. from the time of tripping. The flicker of lights on the system is hardly noticeable.

DIESEL ENGINE UPKEEP



PART XXIV, MAINTENANCE OF PACKINGS, GASKETS AND ENGINE PLANT JOINTS. PROPER SELECTION OF PACKING MATERIALS. JOINT TYPES. PROPER METHODS OF USING GASKETS. BY EDWARD J. KUNZE

ALTHOUGH DESTRUCTION OF packing materials and gaskets may not result in sudden engine stoppage, loss of life or limb, failure of these important adjuncts to Diesel power plant practice may result in heavy losses. This is due largely to the fact that hardly any element on an engine receives so little consideration by the average operator. Because of this, the subject of packings deserves a place in this series of articles.

PROPER SELECTION OF MATERIAL IS IMPORTANT

Successful use of packings depends upon proper selection of material as well as upon its proper use so the material must be selected to fulfill a particular service. Common packing materials are: asbestos, cotton, flax, fiber hemp, graphite, rubber, lead, babbitt, antimony, aluminum, copper, bronze and cast iron. Common gasket materials are: paper, leather, cotton, fiber, cork, lead, aluminum and copper. It is apparent that no one of these materials will serve all purposes equally well.

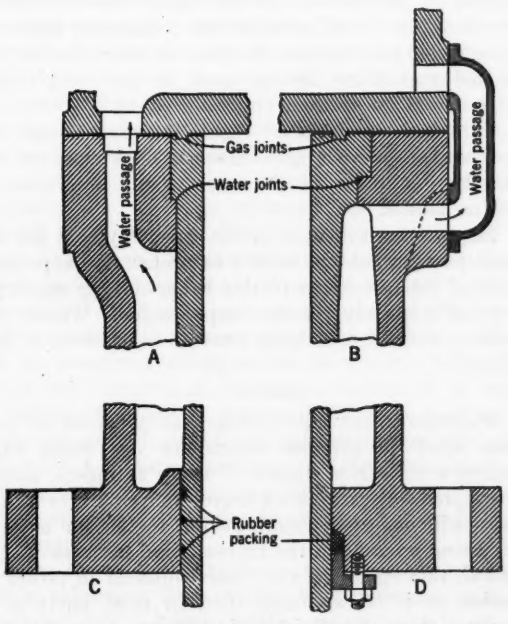


FIG. 1. FORMS OF JOINTS FOR SEPARATE LINER CYLINDERS

JOINT TYPES

Three types of joints are found in Diesel engine practice: ground joints for high pressures which serve well if they are handled carefully to avoid damage due to abrasion or unequal tightening; soft-packing joints which are used particularly where pressures are low and surfaces uneven; compression joints which combine gaskets of moderately soft metal such as brass or copper.

Material and thickness of gasket must be determined by the kind of fluid to be held, the pressure and temperature, the design and finish of the surfaces and the fastenings. If the surfaces are uneven or the material springs between the fastenings, thick, soft gaskets should be used. This fastening is not adapted to high pressures because of the likelihood of blowing out the gasket. Thin, hard gaskets should be used where high pressures are to be held but they are more difficult to tighten up unless the surfaces are finished accurately.

Comparatively soft thick gaskets may be used for high pressures in tongue and grooved joints. Raised beads on such joints facilitate tightness, where a soft metal such as lead is used for a gasket, by pressing in and spreading the lead as the joint is tightened. One concentric ring bead is usually turned in the female flange while two are turned in the male flange. Corrugated gaskets accomplish this same purpose where the tongues and grooves are flat on the surface.

CAREFUL FIT AVOIDS NEED OF PACKING

In most cases fuel pump plungers are no longer packed. Careful grinding of the plunger and its rapid short movement in service have made packing unnecessary. Where elimination of packing can be done successfully it is desirable.

Soft packing should be avoided on fuel valves and fuel pump plungers because of the tendency to collect grit. Metallic packings, such as a mixture of shredded lead, graphite and oil, are best adapted for fuel valves. Beveled rings of babbitt and bronze which fit over one another in the stuffing box so that the babbitt is in contact with the valve stem while the bronze presses against the wall of the stuffing box, may last for years without requiring renewal but they are expensive.

Where stuffing box expansion joints are used on exhaust pipes, asbestos rope or wicking should be used

for packing. For this service such a joint holds well for a short time but soon bakes hard and fills with soot which makes it resistant to tightening. It does little good to add new packing on top of a stuffing box partly filled with old asbestos so the old packing should be replaced. It is best to avoid the use of packed expansion joints by substituting long loops or corrugated pipe.

Cardboard or compressed asbestos serves well for gasket material for low pressure fuel oil lines. Cardboard rings cut to fit inside of the bolt circles of flanges and softened in water before being pressed between the flanges, make excellent joints for pressures below 150 lb. For oil pressures of 500 to 600 lb., compressed asbestos sheet stands better but is more expensive. Rubber is unsuited where it comes in contact with oil because of its tendency to rot.

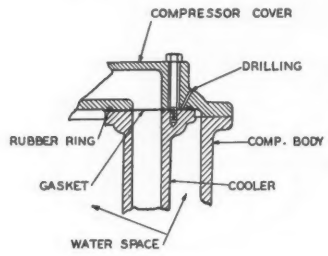


FIG. 2

FIG. 2 CYLINDER HEAD CONNECTION SHOWING COMBINED USE OF RUBBER RING AND FLAT GASKET

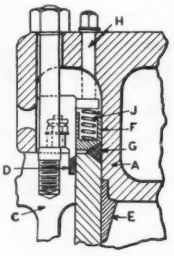


FIG. 3

FIG. 3 CYLINDER HEAD PACKING SHOWING USE OF A SPECIAL GLAND

Where still higher pressures of 1000 lb. or more are to be held, sheet copper or copper rings made of 8 or 10 B & S gage copper wire or flat copper wire make good gaskets. The wire is annealed if it is hard and, after scarfing, the ends are soldered.

Instalment Steam

By Arthur J. Herschmann

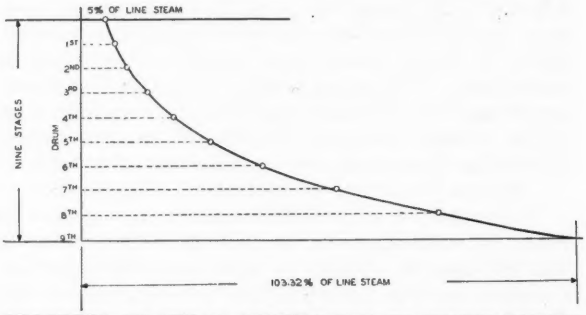
ON PAGE 289 of the issue of April 1, of Power Plant Engineering, a Brown-Boveri high-pressure boiler is described which, so to speak, makes steam on the instalment plan.

Because I represent the Loeffler System in the United States, I want to comment on this article which treads a bit on my toes. If this youngster of a boiler has merit, why make its bow to the public, leaning on the unwilling arm of the Loeffler boiler which it drags along without good reason, especially in view of the existing patent situation?

This article states that no circulating pump is required and gives food for reflection to the many engineers who understand what the Loeffler circulating steam pump means and accomplishes, by adding that a steam pump *may be used* after all. True enough it would be a small steam pump but there is nothing stated about the energy requirement of the extra pump which is used to inject water amounting to 40 per cent of the superheated steam which enters the drums of each stage; and there would be "no more than 10 stages" as the article modestly concedes. The initial pressure of this boiler is 2280 lb. That equals an increase of 20 per cent or 432 lb., based on the line steam pressure which is given at 1848 lb. The Loeffler circulating pump boosts only sufficiently to overcome superheater resistance of about 50 lb. or less than 3 per cent of the line pressure.

If these evaporators for the 10 stages are all of the same size, we must logically conclude that for each of the last stages several of these drums, no matter how small each drum may be, will have to be arranged in parallel. Herewith is a curve plotted to visualize this point and showing how the steam making by injection progresses. To equal the ability of the Loeffler boiler to control fluctuations of the load, would not this cascade boiler require ever so many of its small evaporators, until their aggregate cubic contents equaled those of the Loeffler drums?

In the article it is stated that some of the injected feedwater is evaporated, while the remainder "flows back to the water reservoir." I am sure that experienced engineers know such injections will necessarily have to be made in proportion to the circulated steam. Should they remain constant, what would keep the injected water from overflowing at times? We can also see that the pressure conditions in these stage evaporators will vary with the load of the boiler in their relation to the pressure in the water reservoir and we may therefore doubt whether the remainder flows back to the water reservoir or whether an assortment of complicated regulating devices must be provided to keep water and steam in their right places.



PROGRESS OF STEAM GENERATION IN BROWN-BOVERI BOILER

This same complicated regulation would seem to be necessary to prevent an occasional back rush of water into the last stage which water would then reach the turbine blades.

May we not conclude in the same way that the small steam pump would be unable to protect the superheater tubes of the last stages of this boiler during starting, as it would cool only the first superheater? Would it not require, therefore, a long time to start such a boiler safely?

Flettner rotating cylinders as a source of power from wind to generate electricity are being experimented with in New Jersey. Twenty cylinders, mounted on coupled flat cars which travel a circular track ½ mi. diam. will have generators geared to the car axles and delivering current to the transmission network. If successful, this opens up a new development in power generation as it is estimated that, in most parts of this country, there is sufficient wind 85 per cent of the time to make operation possible.

Readers' Conference

Silencing Engine Exhaust

ARRANGEEMENTS for silencing exhaust in gas engines described on page 506 of the June 15th issue bring to mind two designs which I have seen used effectively. The first is shown by Fig. 1 with the exhaust piped into a large drum with removable head. At the upper end

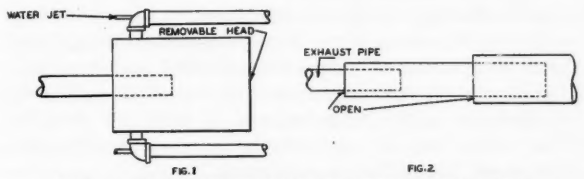


FIG. 1. PLAN VIEW OF DRUM TYPE SILENCER
FIG. 2. SIMPLE AND EFFECTIVE DESIGN EASILY MADE

of the drum, two ells, with about 20 ft. of pipe on each, lead from opposite sides. In one installation this reduced the noise very materially and when a ½ in. stream of water was allowed to trickle down the pipe the noise was still further reduced. The removable head is necessary so that it can be easily replaced as the vibration makes the metal very brittle.

The cistern design shown by Mr. Altizer is good but the most satisfactory way that I have found is to superimpose several pipes increasing in size as shown by Fig. 2. The ends are left open and the exhaust acts as a jet pump which draws the air along with it. Where the pipe can be inclined downward a small stream of water is also beneficial.

St. Louis, Mo. L. R. BAKER

High Pressure Boiler Feed Pumps

HIGH PRESSURE BOILER feed pumps are subjected to severe service and a description of some of the troubles and remedies encountered in one high pressure plant might be of interest to operators and designers of this equipment. The plant referred to is a 1400-lb. plant, with condensate from the hotwell pumped through a No. 1 extraction heater, to a No. 2 deaerating heater to the suction of either of two primary boiler feed pumps at 270 deg. F. and 45 lb. ga. pressure. The discharge of the primary feed pumps condensate passes through the No. 3 and No. 4 high pressure closed extraction heater and enters the secondary feed pumps at from 450 to 700 lb. gage pressure and maximum temperature of 430 deg. F.

Secondary feed pumps discharge at from 1500 to 1600 lb. pressure through economizers to the boiler. All pumps are installed in duplicate, either set of which can supply the plant at full load. Primary feed pumps are 6-stage centrifugals driven by 750 hp. variable speed wound rotor motors. Secondary pumps are driven by 1250-hp. 3600 r.p.m. constant speed motors. The discharge pressure is controlled by the speed of the primary feed pump.

These secondary pumps are multi-stage centrifugal with a balancing disc in the high pressure end, an equalizing line connecting the casing outside of the balancing drum with the suction end giving suction pressure at each end of the pump. A metal labyrinth seal was used outside of the balancing drum on these pumps, with a ¾ in. line direct from the discharge of the primary feed pumps supplying sealing water to the inboard end of the labyrinth seals and a 1½ in. leakoff line connected from the outboard end of the labyrinth to the deaerating heater operating at 35 lb. gage pressure.

Usual type of stuffing boxes were on the outside of the labyrinth casing, each taking about 10 rings of packing and a water sealing ring. Condensate was circulated through ½ in. connections tapped into the top and bottom of the stuffing boxes. After considerable experimenting with different methods of packing it was found best results were had by alternating hard (not metallic) and soft rings of packing in the high temperature grades.

When first running the pump after repacking, the stuffing box often heated and smoked considerably. In this case the valve on the condensate cooling line from the stuffing box was nearly closed for a few moments until the internal steam pressure opened up a path along the shaft for the water for packing lubrication. Adjustment of the lantern gland was kept at a point where a stream of water about the size of a pencil was leaking out along the shaft at all times when the pump was in operation.

It was found that after some time excessive wear was taking place in the labyrinth rings due to the cutting action of the hot water. This resulted in a high stuffing box pressure, giving short life to packing and loss from excessive labyrinth leakoff which was really bypassing the pump by passing the water back through the leakoff and deaerating heater to the primary pump suction. The following steps were taken to correct this. A mercury type reducing valve was placed in the primary pump discharge line between the primary pump and No. 3 feedwater heater.

This valve was set to give a 50 lb. reduction in pressure regardless of the discharge pressure of the primary pump. The ¾ in. sealing line to the secondary pump labyrinth was then taken off from between the primary pump and this reducing valve. This resulted in the labyrinth receiving water at 270 deg. F. and at a pressure 50 lb. higher than the high temperature water inside of the pump that leaked past the balancing drum. The higher pressure water coming into the labyrinth seal tended to force the hotter water back through the equalizing line instead of allowing it to leak out through the labyrinth.

As only one primary and one secondary feed pump were in operation at one time it had been the practice to leave all valves open on the duplicate pump that was shut down. Some cutting action took place in the pump that was idle so the secondary pump suction valve, discharge valve, and labyrinth high pressure sealing valve were then kept closed on the idle pump. A ½ in. line was taken from the pressure side of the labyrinth sealing valve to the pump side of the suction valve (secondary pump) and an eighth inch orifice placed in this line. In this manner a small flow of hot water was insured through the idle pump and out the labyrinth leakoff

keeping it at near operating temperature without any cutting action.

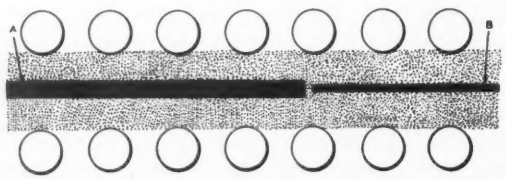
Another difficulty encountered with this system came at very low loads. The secondary feed pump being constant high speed caused a slight steam binding in its suction lines when the primary pump was operating at low speed. This caused pressure fluctuations and serious pipe vibration. When these low loads occurred this trouble was prevented by partly bypassing No. 1 feedwater heater.

West Roxbury, Mass. HARRY M. SPRING.

Plastic Boiler Baffles

IN CONNECTION with the baffling of water-tube boilers it is important that the supporting separator of plastic material should be placed centrally between the tubes as illustrated herewith.

If placed out of center, closer to one row of tubes than the other, the plastic will naturally possess greater strength on the thick side than on the thin side and in



PLACE THE SEPARATOR IN THE CENTER OF THE TUBE ALLEY.

the event of renewal of tubes, there is danger that the material on the thin side may crumble. If the separator is quite close to one tube row, a slight leak may be left between the separator and the tubes owing to the difficulty of ramming plastic into the narrow space.

Another thing, the thinner the supporting separator, the better. The thick separator, even when perfectly central, gives a thinner wall of plastic between the separator and tubes than does a thin one, as indicated.

W. F. SCHAPHORST.

Steam Purifier Experience

ON PAGE 395 of May 1, 1932 issue of "Power Plant Engineering" appears a request for the results of experiences with steam purifiers in boilers or separators.

When I took charge of our plant in 1925, I found a condition that was most deplorable.

I started working on the water supply as a beginning and tried several methods of water treatment but fought an up-hill game for over 2 yr., due in part to the ever changing hardness of our water.

We use sub-surface water and the hardness will change from 11 grains per gallon to 27 grains per gallon, either up or down in 24 hr.

This made it almost impossible properly to treat the water as we were either overtreating or undertreating so much of the time that our steam conditions were about as bad as they could well be.

Finally a treatment was found that stopped the mammoth slugs of water going over into the steam lines. This lengthened out the period of turbine cleaning from 90 days to 6 months and made it possible to keep plugs in the superheater headers tight from one boiler washing period to the next; yet we had considerable trouble from a very finely divided magnesia that floats on the surface of the water and goes over with the steam, when any entrained moisture is present.

Then a centrifugal purifier was installed in the drum of one of our boilers at the nozzle entrance, piping the discharge outside the drum to a trap that is designed to handle a large volume of water quickly.

Upon putting this boiler on a test, we found the calorimeter reading to run from 99.8 to 99.834 per cent dry steam even up to 300 per cent of rating.

Purifiers were then installed in the other three boilers.

Since installing these purifiers we have had no trouble whatever with our superheaters. Our turbines we take down once a year for general inspection and find the blading practically free from deposit and erosion.

The savings accruing from the installation of these purifiers are in the neighborhood of $600 per year for labor alone, not to say anything about replacement charges on the different equipment.

Our superheat was increased 20 deg. and the blowdown period of frequency was reduced 12 per cent.

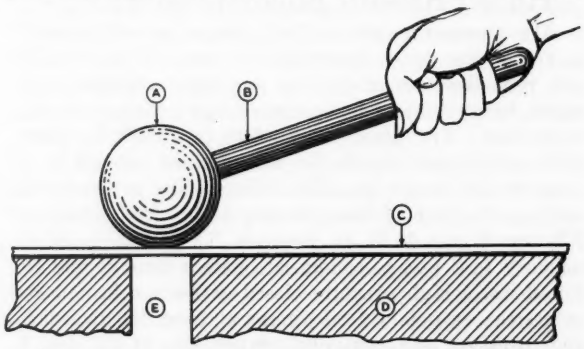
The type unit we installed is self cleaning and together with the traps that were recommended and purchased with them have required no repairs so, in 3½ yr. the first cost has been the total cost. The unit we use is small enough so that it does not interfere with washing or cleaning the drum.

South Bend, Ind. C. O. DRULINER.

Ball Punch for Gaskets

RECENTLY I saw a man cutting bolt holes in sheet rubber packing, to be used on a flange coupling, and I believe that the method he used to do the work is worth recording.

The tool he used consisted of a ¾-in. steel ball. A, with a short piece of iron rod B, screwed into a threaded hole. The rubber sheet packing C, was laid on the flange



STRIKING STEEL BALL WITH MALLET CUTS HOLE IN GASKET

face D. A bolt hole is shown at E. The ball is set on top of the packing over the bolt hole and held in place by the handle B.

Then by striking the ball at the arrow point, a fairly heavy blow with a wooden mallet, the bolt hole will be cut out clean and true with the one blow. When the holes cut are for bolts more than ¾ in. in diameter, a cross cut is made with the pointed end of a pocket knife over each hole, but up to ¾ in. the tool cut out perfectly without any slots being made in the packing.

Toronto, Can. JAMES E. NOBLE.

Plant Operation Problems

Use of Term Degree-Day

WHAT IS meant by the term "degree-day" as applied to steam heating and how is it used?

H. G. C.

A. The term "degree-day" applies to the difference between and assumed desirable indoor temperature over the 24-hr. period and a lower average outside temperature over the same period. The "degree-day" standard was empirically determined by the American Gas Association to be the difference between 65 deg. F. and the daily mean outside temperature when the latter is below 65 deg. F. Through numerous records, the association estimated that an average residence maintains a temperature of 70 deg. F. for 18 hr. a day and allows it to drop to as low as 50 deg. for 6 hr. out of the 24 which gives an average of 65 deg. for the entire 24 hr.

Thus the base of 65 deg. F. is used for inside temperature of 70 deg. F. when residential heating is being considered. From the data collected it was demonstrated that 65 deg. F. usually is the maximum outside temperature at which fuel is burned to supply heat for a residence. The investigations also pointed to the fact that the fuel consumed varied almost directly as the difference between 65 deg. F. and the lower outside temperature.

For estimating fuel requirements, tables have been compiled giving degree-days for the principal localities in the United States and Canada. These values are calculated from the formula:

$$D = (65\text{-}t_a) \times N \div 24$$

In which D = degree-days standard

t_a = average outside temperature, deg. F.

N = number of hours of heating season corresponding to average temperature t_a.

By this means the degree-days for Detroit, Mich., are calculated to be 6202; for Marquette, 8866; for St. Louis, Mo., 4583; for Mobile, Ala., 1439; for Winnipeg, Man., 11,166.

The general formula for fuel requirements is:

$$F = \frac{H \times (t - t_a) \times N}{(t - t_o) \times C \times E}$$

In which t_a and N are as above

F = Quantity of fuel required for a heating season.

H = Calculated heat loss of building based on outside temperature of t_a, B.t.u. per hr.

t = Inside temperature, deg. F.

t_o = Outside design temperature, deg. F.

C = Calorific value of one unit of fuel, the unit being the same as that on which F is based.

E = Efficiency of utilization of fuel, per cent.

When residential heating is considered, the standard degree-days may be used and the formula becomes

$$F = \frac{24\ HD}{(t - t_o) \times C \times E}$$

For other than residential heating, this last formula does not apply as the average indoor temperature during the heating season varies from 65 deg. F. with the kind of work done in the building and the hours the building is occupied.

Reversed Polarity

IN LOOKING over June 1st issue the article on page 467 by Leon Pollard interested me inasmuch as my experience has carried me along quite similar lines. This is an interesting discussion on reversal of polarity but I imagine almost any railroad engineer (electric power house—not locomotive) has probably met with parallel case. It reminded me of perhaps a slightly different case when an engineer in a factory found his polarity reversed about three out of five mornings.

His generator was of small capacity and ordinarily used for lighting but upon one occasion a small drive had to be provided for a pattern shop drive in a building not serviced by shafting. So a small direct current motor was installed and the current taken from the small lighting generator.

The first irregularity which arose came about a week after the new drive was in operation. The engineer started his engine—a small slow speed unit—as usual and the generator came up to speed with the lights aglow at the proper brilliancy but the voltmeter refused to register.

About the middle of the forenoon after trying all kinds of mental arithmetic the engineer reversed the leads on the voltmeter and it bounded up to 115 where it belonged. The next morning he started in the usual manner but the voltmeter refused to function, so he re-reversed the leads on the instrument and again it operated properly.

For a matter of several months this peculiar happening occurred irregularly—sometimes every morning for a week and again only once during the week. Finally a solution of the mystery was arrived at by the engineer.

The motor in the pattern shop was driving only one short line of shafting but this had several large diameter pulleys for high speed service. His engine being of small capacity was not difficult to boost off the center, so he just shut the throttle and let it stop where it pleased, unless some one happened to be present whom he wished to impress with his engineering ability. In the latter instance he would go to the miniature switchboard, glance at the voltmeter, pull the various line switches and the main switch, light his brass trimmed lantern, place it at the crank so he could see its position and then work the valve gear to a perfect stop.

After a demonstration of this kind, the voltmeter would be O. K. in the morning, but if he was all alone and in a hurry to catch the 6:04 car at the corner, and just simply spun the throttle shut and "beat it" for the car, the polarity would be reversed in the morning.

The engine and generator being connected to a certain amount of factory shafting took about one and a half minutes to come to rest but the motor in the pat-

tern shop which was never stopped by the boss pattern maker (he being several blocks away at shutting time as were also his two assistants) continued to run for about three minutes and kicked back into the generator or dynamo. It made no difference to the generator or to the motor which way the current flowed and as storage batteries were not heard of then in that locality (42 yr. ago) and consequently were not being charged, no one ever knew that the electricity sometimes went through the line backwards instead of forwards.

Lawrence, Mass. C. J. WILDER

Why Did Polarity of Large Generator Reverse?

IN THE POWER plant with which I am connected we have two Corliss engines direct connected to direct current generators, a large engine used during the day and a smaller one at night. These generators were connected to the switch board by a three pole, double throw switch. The center pole was not connected as the generators were not paralleled.

In changing over from one unit to the other, it was necessary to throw the switch quickly from the top connections to the lower ones, causing a momentary interruption of the service. The large generator was connected to upper contacts, the smaller unit to the lower contacts.

One morning the large generator was found to have reversed polarity and an another morning was found to have lost its residual magnetism entirely.

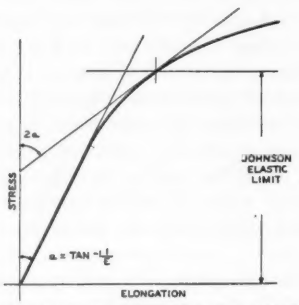
Later another switch was added and the two generators connected to separate switches and equalized by using the center poles of the switches for the equalizer connection. A short time afterwards the same trouble made its appearance in the large generator when trying to start up in the morning. The small generator never gave any trouble.

I wonder if any readers can explain what the nature of the trouble was in both of these instances.

Brooklyn, N. Y. F. V. GREENE.

Turbine Design

IN THE ARTICLE, Problems in Steam Turbine Design on page 526 of the July 1 issue, there is shown on Fig. 2 a curve marked Johnson Limit. What does this mean?



ILLUSTRATING THE METHOD OF FINDING THE JOHNSON LIMIT

A. The Johnson Elastic limit, to use the full name is obtained by drawing a tangent to the stress-strain curve, the slope of this tangent being one half of that of the elastic part of the curve. This is shown by the attached sketch. Plotting these values for different temperatures gives the curve shown in Fig. 2 of the original article.

What Happens When the Field Switch Opens?

ON PAGES 507 and 508 of the June 15th issue of Power Plant Engineering, E. W. J. and G. H. E. presented their ideas of what happens when the field switch opens.

E. W. J. states that if the field of one of two alternators operating in parallel be opened, that the kw. load on either machine will not be changed, while G. H. E. contends that the machine that lost its field would idle along while the other machines will pick up the load formerly carried by it.

I disagree with both of these gentlemen. What is likely to occur is dependent on the prime mover. If the prime mover is a synchronous motor and the two systems locked together by other frequency changer sets of ample capacity, or if the prime mover is of absolute constant speed, regardless of load, I agree with G. H. E.

When the average alternator loses its field excitation, it becomes an induction generator. An induction generator must rotate above synchronous speed to supply power to the system, taking its magnetizing current from the line.

If two or more turbo generators, engine driven generators or a combination of both are operating in parallel and the excitation removed from one of them, the unit without excitation will speed up slightly, depending upon its governor regulating characteristics; its kw. load will decrease considerable but will not drop to zero; the kw. drop will depend somewhat on the design of the field poles. The ammeters on this machine will likely read higher than under normal load conditions due to taking its magnetizing current from the other machines.

G. H. E. states that the machines are already in phase and all that is necessary is to close the field switch. The machines are not in phase under this condition, but upon closing the field switch I have never seen a case where a machine failed to fall in step readily. I have seen cases where five machines excited from a common exciter bus, the exciter bus went dead, all alternator main and field switches left closed, the exciter bus reenergized and all machines fell in step without any noise or hunting.

Some years ago while operating in a small plant, we were running two 1500-kw. turbo generators in parallel carrying about 1000 kw. on each. Suddenly one of the units dropped to 500 kw. and was running considerably above normal speed and the field ammeter indicated zero, while the other machine had increased its load to 1500 kw. After shutting down and dismantling the faulty machine, we found one of the field leads between the collector ring and the winding proper burned off.

Very truly yours, E. B. HEISE.

Michigan City, Ind.

Motor Bearing Lubrication

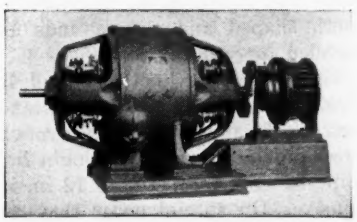
FOR MEDIUM size motors with ball or roller bearings, what kind of lubricant should be used and how can I tell when a bearing has the proper amount to give good lubrication yet avoid creeping along the shaft onto commutator and windings?

Peru, Ind. C. J.

New Equipment

Constant-Tension Regulator

TO GIVE constant tension in winding strip metal, paper, cloth or other materials onto reels, Reliance Electric & Eng. Co. has developed a regulator as illustrated. The armature has a torque winding connected in series with the motor driving the winding machine; also a "spring"

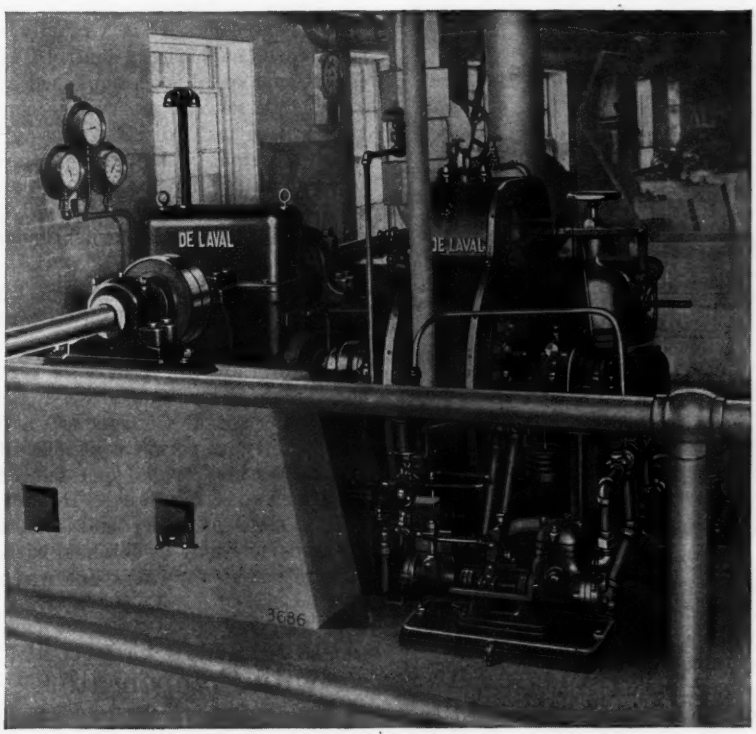


winding, which acts to oppose the torque winding. With current in the two windings equal, there is no movement of the regulator. As current in the torque winding increases, giving greater torque, the regulator moves, turning a rheostat connected to the regulator shaft so as to decrease voltage on the driving motor. Decrease in torque-winding current produces the opposite action. For unwinding, the regulator is used with a generator to hold tension constant, no friction brakes being needed.

Variable Speed Governor for Steam Turbine Drives

STEAM TURBINES are being widely introduced for driving paper machines, as the clean exhaust steam can be utilized in paper drying or other processes and the power is obtained at small expenditure of heat. By the use of speed reducing gears, the steam turbine may generally be coupled directly to a paper machine, with either single or double-end drive, thus saving the cost of and the losses in electric generator, transformer, wiring and motors. Where a properly designed governor is employed, the speed regulation of turbines is extremely close, which is important in paper making; where variable speed is required, the regulating equipment is inexpensive.

To give accurate variable speed control, a new form of governor, which is positively driven through gears from the turbine shaft and acts directly on the speed control valve has been developed by the De Laval Steam Turbine Co., Trenton, N. J. The accompanying cut shows a turbine and worm reduction gear supplied by that company to the Gilbert Paper Co. for driving a paper machine. At full speed the turbine, which is designed to operate on steam at 250 lb. pressure and 125 deg. F. superheat, runs at 5040 r.p.m., while the slow-speed gear shaft turns at 288 r.p.m., the relatively large speed reduction making possible good turbine efficiency, even at reduced paper machine speeds.



Speed of the gear shaft may be regulated and held closely at any point between 288 r.p.m. and 72 r.p.m. by means of the small hand wheel which is to be seen at the top of the governor casing, an indicator which registers on a scale immediately below the hand wheel showing the speed of the driven machine. Speed adjustments up to a total range of 16 to 1 are possible.

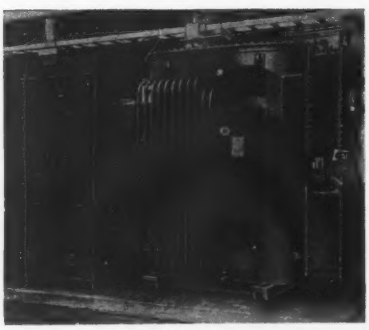
While of simple construction the governor is powerful and accurate throughout the entire speed range and can be arranged either for adjustment at the turbine or by remote control. It actuates a balanced, double-seated, steam admission valve through a lever arrangement, the speed governor valve, also the emergency, over-speed, shut-off valve being contained within a housing formed in the turbine case cover. The valve port communicates directly with the steam chest formed in the casing cover; these, with the nozzles in which the steam is expanded are the only parts of the turbine coming into contact with steam at high pressure and high temperature. The emergency overspeed governor gear includes a trip handle by means of which the turbine may be shut down.

Turbines equipped with these governors are available for high and low steam pressures and for high superheat, in several hp. ratings.

Outdoor Distribution Unit for Medium Voltage Service

A FACTORY ASSEMBLED switchgear and transformer unit for either radial feeder or primary network distribution systems bas been announced by the Westinghouse Electric and Manufacturing Company. The three phase 1500 kv-a. (2000 kv-a. with blowers) transformer can be supplied for high tension transmission voltages up to 34.5 kv. and low voltages as required, usually 2300/4000 three phase four wire. The high tension pothead compartment includes a three position disconnecting and grounding switch. An automatic underload tap changer operating on the high tension winding takes care of voltage regulation without the use of induction feeder voltage regulators.

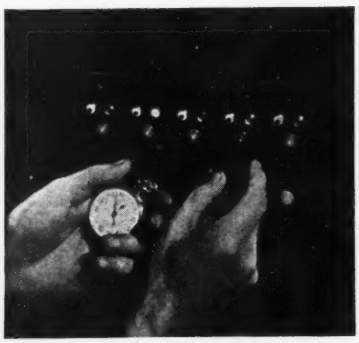
Low tension connections from the transformer are carried to the switchgear through a connecting compartment. The switchgear unit comprises six sections, each with front and rear doors, the section next to the transformer being arranged for metering equipment, tripping battery and charger, and operating transformer for the circuit breaker mechanisms. The sec-



ond section contains the transformer breaker and its disconnecting switches and the other four sections contain breakers for the feeders or network mains. Complete relay and control equipment is mounted on a panel in the front compartment of each section, and ample space is provided in the rear for pothead mounting. The circuit breakers are the single round tank type, a-c. Rectox solenoid operated and the standard ratings are 100,000 and 250,000 kv-a. interrupting capacity. The bus is Micarta insulated throughout.

New High Speed Supervisory Control

AN ENTIRELY new supervisory control—Polaricode—which is new in principle and which it is claimed sets a new standard of control speed has been announced by The Westinghouse Electric & Manufacturing Co. The high speed of this new system permits selection and operation of the control circuits of any piece of remotely controlled apparatus in



the almost unbelievable time of less than one second. It is virtually a split-second supervisory control. The exceptional speed is accomplished by a principle new to supervisory control known as "direct selection" which eliminates the loss of time inherent in previous selective supervisory systems operated by either coded impulses or by synchronous selection.

Polaricode is available for use on 2 and 4 line wires. The two wire type controls up to 25 remote apparatus units and the four wire type controls up to 2500 units—all at the same super speed. Both the two and four wire types permit a number of remote stations to be operated on the same two or four wires. In addition, remote metering and remote synchronizing may be obtained without the use of any extra line wires.

Temperature Controller with Compensator

MASON REGULATOR Co., Boston, announces a recording temperature controller with thermo-pressure regulator to control the temperature by throttling the supply of heating or cooling medium, also compensate the pressure and resultant rate of flow of that medium. Pressure changes, which might vary the temperature are thus checked before the temperature has a chance to fluctuate. Compound balanced pilot valve keeps the control valve diaphragm always floating and dual helical temperature coils provide continuous check to give a true chart record.

Shaped Welding Nipples

MIDWEST Piping & Supply Co., Inc., of St. Louis, Mo., has recently placed on the market a line of shaped welding nipples which eliminate all templates when saddling one pipe upon another. The nipple is placed in position before the opening is cut in the pipe upon which it is to be saddled, the correct opening being then easily traced from the nipple contact line, saving time and assuring an accurate fit. Both shaped and square ends are beveled for welding.

Shaped nipples, both 90- and 45-deg., are regularly made from standard weight and extra heavy wrought steel pipe and genuine wrought iron pipe in sizes from 1¼ to 12 in. inclusive. On special order they can be provided with any type of forged lap or flange, also other angles, lengths and sizes are available.

Unique Principle Employed in G-E Oil Furnace

A NEW PRINCIPLE of combustion is employed in the new oil furnace which has been announced by the General Electric Co. The announcement of the new product, which will be marketed by the newly created air conditioning department, follows several years of study. The furnace is designed for use primarily in homes. Economy of operation, safety, quietness, and its fully automatic operation are the outstanding advantages claimed for the equipment. The furnace comprises a coordinated boiler, burner, and control, designed and manufactured as one unit. It will automatically maintain an even temperature in the home in winter, and will heat water for domestic use the year round, without manual supervision. It is, according to the manufacturers, quiet, clean, and presenting a finished appearance which permits the furnace room to be transformed into another living room.

Since all parts are designed especially for use together, under a comprehensive plan, the new furnace is easily installed and takes up little floor space. Its maximum output is 257,000 B.t.u. per hr. The coördi-

nation in design of the combustion space and boiler surface with the burner capacity assures high efficiency and economical operation.

At the lower part of the unit is located the boiler and the combustion chamber. In the upper section, carefully insulated from the lower, are the controlling devices and the oil burner mechanism which prepares the air and oil for combustion. The oil burner nozzle and the electrodes for the electric arc ignition project down into the combustion space through sealed openings.

The principle of combustion is unique. Finely divided particles of oil are blown from the nozzle under air pressure and are directed towards the bottom of the furnace. It is claimed in this process, a single drop of oil is broken into more than 100,000,000 particles. This process was developed by the research engineers of the General Electric Co.

New Unit for Richmond Station

As part of an electrical project calling for the expenditure of 8½ million dollars in the next two years, a contract of approximately 1¾ million dollars has just been awarded to the Westinghouse Electric and Manufacturing Company by the Philadelphia Electric Company for a 183,000 kv-a. turbine generator to be installed at the Richmond Generating plant, on the Delaware River, Philadelphia, Pa. The Westinghouse contract is among the largest awarded for generating equipment in several years.

The single cylinder generating set will consist of a 1800 r.p.m. turbine, as powerful as any yet built, and a 165,000 kw., 3 phase, 60 cycle, 13.8 kv. double winding generator. The use of the best materials available, special ventilation, and expert coördination of design details will make this unit the most advanced of its kind in the world. About two years will be required to complete the installation; the new equipment is to be ready for commercial service by November 1, 1934.

The Philadelphia Company estimated that 800 men eventually will be employed directly on the construction project—the number reaching 100 at the end of this year, 300 in he early part of 1933, 500 by the latter part of 1933; and 800 in the early part of 1934. In addition to this, there will be the employment given workmen from the manufacture of articles needed for installation and for the production of material to be used.

Of the total eight and one-half million dollars—it is estimated that $2,758,000 will be expended directly on labor by the Philadelphia Electric Co. Much of the remaining $5,472,000 will go into finished material and equipment.

In awarding the contract, W. H. Taylor, President of the Philadelphia Electric Company, said: "This contract, based on careful engineering study, is a reflection of our faith in the soundness of business. A public utility must anticipate the requirements of its customers and be prepared to supply them.

During the depression period we have not only retained virtually all of our customers, but have added additional load, as for example—the electrified load of the Pennsylvania and Reading Railroads. As this connected load begins to approach normal operation—the demand on our capacity will require largely increased facilities.

We look to the future with optimism, confident that business will return to normalcy within a reasonable time and our policy of expansion gives expression to that confidence and belief."

New Condit oil circuit breaker is announced, manually or electrically operated, for 2000 and 3000 amp. at 7500 v. All poles are in one tank; mechanism is enclosed with rapid acceleration and easy closure. A cast frame supports bushings, studs and mechanism, as well as the tank, which is welded from steel plates and is lined as are the reinforcing separators between phases, with high-resistance dielectric material. Oil and gas separator, inverted laminated brushes to carry current, with large arcing contacts and magnetic blowout are some of the features.

Developed for general and industrial applications, the Self-Syn motor of the Ideal Electric & Mfg. Co. is started by a hand-operated compensator. It is a truly synchronous motor, yet, if pulled out of step due to overload or drop of line voltage, it will automatically resynchronize instead of stalling. Sizes are from 5 to 100 hp. at 900, 1200 and 1800 r.p.m.

John Scott Citation Goes to Slepian

Dr. Joseph Slepian, consulting research engineer of the Westinghouse Electric and Manufacturing Company, received the John Scott medal, certificate and premium of $1,000, at the Union League Club, Philadelphia, June 13.

According to the announcement by the Board of Directors of City Trusts in Philadelphia, the citation is awarded "for discoveries in the field of the deionization of gases and fundamental and outstanding inventions involving these discoveries." The advisory committee assisting the Board, is composed of Samuel M. Vauclain, chairman of the board of

Baldwin Locomotive Works; Solomon M. Swaab, consulting engineer, and Herbert T. Herr, vice-president, Westinghouse Electric.

John Scott, a chemist of Saint Patrick Square, Edinburgh, Scotland, founded the awards in 1816 when he bequeathed to the City of Philadelphia $4000 with the stipulation that the income from the fund was to be "distributed to ingenious men and women who make useful inventions. . . ."

After the fund had grown to $100,000 in 1917, court orders enlarged its use and specified that the premiums were to be awarded "for inventions that will be useful to mankind in the development of chemical, medical, or any other

science or in the development of industry in any form; the test being that it may add to the comfort, welfare and happiness of mankind."

Dr. Slepian's citation refers to conspicuous work in circuit interrupting devices and the use of his unique principle of deionization in the destruction of powerful and violent electric arcs. His contribution to "the comfort, welfare and happiness of mankind," was in making higher voltages possible on transmission lines and making this increased service both dependable and safe for central stations, industrial plants and private homes.

Deion circuit breakers in conjunction with deion lightning protectors produce this high degree of safety by practically eliminating the possibility of property damage from overloads, short circuits and lightning surges.

A.S.M.E. Officers Nominated

ANNOUNCEMENT of the nominations for officers of the American Society of Mechanical Engineers for 1933 was made by the nominating committee at the Semi-Annual Meeting of the Society held at Bigwin, Ont., Can., during the week of June 27. Election will be by letter ballot of the entire membership closing on September 27. The nominees presented by the committee are:

President, A. A. Potter, Dean, Schools of Engineering, Purdue University, Lafayette, Ind. Vice-Presidents, H. V. Coes, Consulting Management Engineer, Ford, Bacon & Davis, Inc., 39 Broadway, New York, N. Y.; James D. Cunningham, President Republic Flow Meters Corp., 2240 Diversey Parkway, Chicago, Ill.; C. F. Hirshfeld, Chief of Research Department, Detroit Edison Co., 2000 2nd Ave., Detroit, Mich.

Managers, R. L. Sackett, Dean of Engineering, Pennsylvania State College, State College, Pa.; Alexander D. Bailey, Superintendent Generating Stations, Commonwealth Edison Co., 22nd and Fisk Streets, Chicago, Ill.; John A. Hunter, Professor of M. E., University of Colorado, Boulder, Colo.

Delegates to the American Engineering Council, B. R. Van Leer, Washington, D. C., J. W. Roe, New York City, D. Robert Yarnall, Philadelphia, B. M. Brigman, Louisville, Ky., Ernest Kreher, Tampa, Fla., Hugo Diemer, Chicago, Ill., W. A. Hanley, Indianapolis, Ind., G. E. Pellissier, Holyoke, Mass., W. S. Conant, Washington, D. C., T. R. Weymouth, New York, N. Y.

Death of Robert B. Williamson

ROBERT BAIRD WILLIAMSON, electrical engineer and for 27 yr. a member of the engineering staff of Allis-Chalmers Mfg. Co., died at his home in Milwaukee on June 26th. Since 1910 Mr. Williamson has had charge of the design of all alter-

nating-current rotating machinery built by Allis-Chalmers. This period, being one of great expansion in the electrical industry, has been marked by machinery of ever increasing size and many of the machines designed under his supervision have established world's records for size and efficiency.

Mr. Williamson, who was born at Smith's Falls, Ontario, 59 yr. ago, graduated from Cornell University, Ithaca, N. Y., in 1893, followed by 2 yr. in electrical construction work and 2 yr. as chief draftsman for the Canadian General Electric Co. During 3 yr. from 1897, while serving as instructor in electrical engineering at Lehigh University, the text book Alternating Currents was written with Prof. W. S. Franklin as joint author, for many years a standard text book in leading engineering colleges.

Serving from 1899 to 1905 as principal of the department of electrical engineering of the International Correspondence Schools, he joined the Allis-Chalmers organization at the Norwood, Ohio, plant in 1905.

Mr. Williamson was an engineer, an indefatigable worker, quiet of manner and unassuming, yet with a personality that immediately inspired confidence. A lover of the arts, of literature and music, he traveled extensively and developed a keen sense of humor, his wit and anecdotes being enjoyed by all who were intimately acquainted with him. He was a Fellow of the American Institute of Electrical Engineers, serving on the Board of Managers of the Institute, also on a number of important committees, such as standards and electrical machinery, and was a frequent contributor to its technical publications. He was a member of Engineers Society of Milwaukee, University Club, Westmoor Country Club, of the honorary scientific fraternity, Sigma Xi, and a trustee of Calvary Presbyterian Church, Milwaukee.

News From The Field

THE NEWLY CREATED Air Conditioning Department of the General Electric Company will start commercial operations during the latter part of July in 25 cities in the northeast, it has been announced by J. J. Donovan, manager. District sales representatives are now selecting local business firms to market the new line of air-conditioning and oil-heating equipment. Franchises will be given to only one firm in each city.

General Electric engineers recently announced the development of a new principle of progressive combustion by which it is possible to break a single globule or drop of fuel oil down into more than 10,000,000 parts, thereby permitting a much more economical use of oil for heating. This method of combustion is being incorporated in the new oil furnace.

Cities in which commercial operations are to be started include Boston, Worcester, Springfield, New Bedford, Fall River, Providence, Hartford, New Haven, Bridgeport, Albany, Troy, Schenectady, Utica, Syracuse, Rochester, Jersey City, Newark, Trenton, Camden, Philadelphia, Baltimore, Washington, and New York.

STEPHENS-ADAMSON MFG. CO., of Aurora, Illinois, has established a new branch office at Rochester with headquarters in the Cutler Building. F. H. Wisewell, of Rochester has been appointed district manager and will be in charge of sales and engineering.

JAMES BARRETT, of Brooklyn, died June 22 at the Columbia Presbyterian Medical Center after a short illness. He was a member of the sales staff of Worthington

Pump and Machinery Corp., having served it in various capacities for 40 yr. Mr. Barrett's career covered the period of New York's greatest expansion. He planned the pumping equipment for many of the city's important buildings, including the hospital in which he died, New York Hospital and Cornell Medical College, New York Life Building, Metropolitan Tower, Equitable Building, Salmon Tower, New Waldorf-Astoria Hotel and R. H. Macy Department Store. He was born in Canada, October 14, 1866, and is survived by seven children.

ANNOUNCEMENT has been made of the appointment of Mr. E. F. Sells as Manager of the Washington, D. C., office of the Westinghouse Electric & Manufacturing Company, to fill the vacancy caused by the recent death of Mr. B. H. Hamilton.

WESTINGHOUSE Elec. & Mfg. Co. has received contract from Philadelphia Elec. Co. for a 165,000-kw. turbine-generator to be installed at the Richmond station. Work will be started immediately to employ some 800 men, cost of the new unit being $8,500,000.

TEN MILLION VOLTS OF electricity, five million greater than ever before produced by man in electrical laboratory experiments and approximately one-tenth the voltage of a flash of lightning, was shown in the high voltage engineering laboratory of the General Electric Company at Pittsfield, Mass., on June 11.

This enormous voltage, which is capable of producing an arc of 60 ft., was made possible by a new fifty million kilowatt generator, F. W. Peek, jr., chief engineer, explained. The exact characteristics of the 10,000,000 v. discharge are still unknown, as it was but two days previously that this high voltage was attained for the first time. Likewise, the fields in which the new high voltage will be used, experimentally or otherwise, are yet to be determined; but it will be used in the continued research being conducted by electrical engineers in the study of natural lightning, its effects on electrical generating and transmission apparatus, and ways of protecting such apparatus from damage by lightning. With the increased voltage now available in the laboratory, it becomes possible for the engineers to approximate more closely the effects of natural lightning.

RECENTLY the American Society of Testing Materials changed the old specifications on Gray Iron Castings, known as A48-29T to a new tentative form known as A48-32T as a result of several years research work by the Gray Iron Institute of Cleveland.

Gray iron is now classed into seven tensile groups, ranging from 20,000 to 60,000 lb. per sq. in. The test bar sections were increased in number from one to three in order to provide adequate design information pertaining to various sections in castings.

It will now be possible for producers to state specifically the strength which can be expected in critical sections of their castings. Heretofore the single arbitration test bar has not given results which can be applied satisfactorily throughout the whole range of section sizes.

For the Engineer's Library

COMBUSTION. By American Gas Assn. 9 by 12 in., 208 p., illustrations and tables. Pressboard covers. Third edition, 1932. Price $2.00 net.

Although a third edition, this book has been so fully rewritten that it classes as an entirely new work. It treats of the theoretical principles of combustion and goes fully into practical details of gas burning for all purposes, covering the use of all kinds of gases. In the twelve chapters are covered development of heat by combustion and the chemical reactions involved, measurement of temperature, quantity of heat evolved and amount of gas fuel used, heat absorbed by solids and by liquids in temperature rise and in evaporation, heat conduction, temperatures of ignition for gases, details of gas burners and industrial equipment, furnace essentials and details, temperature control, heat salvage and reclamation, analysis of gases and comparison of value of various fuels. Under each heading the treatment is exceptionally clear and complete. Tables and large, usable charts give the data needed in design and operation of gas-burning installations, illustrations show clearly the details of equipment. Each chapter is followed by a comprehensive bibliograph of books and articles pertaining to the subject of that chapter. The book is well planned, well executed and a valuable addition to technical literature on the subject at a price lower than usual for such books. It is published by American Gas Assn., 420 Lexington Ave., New York City.

OVERHEAD HANDLING is the title of a new book on cranes, No. 214, 108 pages of pictures and descriptive matter, issued by Whiting Corp., Harvey, Ill. The book will be sent free on request.

ROSS REFRIGERATING UNITS for producing chilled water in temperatures from 35 to 70 deg. F. are described in Bulletin No. 325 issued by the Ross Heater and Mfg. Co., Inc., Buffalo, N. Y. This bulletin describes the use of steam ejectors as used with flash evaporators, primary and secondary condensing systems for the cooling of water by evaporation. Units are offered in sizes of from 3 to 400 t. refrigeration in 24 hr.

SEVERAL NEW publications have been issued recently by the Westinghouse Electric and Mfg. Co. Circular C. 1944 covers the new application of economical secondary low voltage networks, to low density load areas fed by overhead lines. Another bulletin, C. 1948 describes the operation and construction of the new Polaricode split-second supervisory control. This system employing a new simplified scheme of operation has as its chief advantage the ability to set up operating circuits in less than one second.

TEMPERATURE MEASUREMENTS in generators, transformers and cable systems is the title of Bulletin No. 871 issued by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. In 28 pages are included illustration and description of instruments for switchboard mounting and for field tests, showing indicating and recording types, also wiring diagrams for connections to thermocouples or to resistance thermometers.

BULLETIN 112 recently issued by Reliance Electric and Engineering Co. describes their line of fully enclosed fan-cooled induction motors.

THE CAMERON MOTORPUMP in sizes from ¼ to 25 hp., capacities 5 to 800 g.p.m., is described and illustrated in a folder sent out by Ingersoll-Rand Co., 11 Broadway, New York City.

WING TURBINE blowers for forced draft service are shown in Bulletin T97 of the L. J. Wing Mfg. Co., 154 W. 14th St., New York City. Photographs, engineering information and operating costs are included.

COCHRANE Bulletin 693 shows the construction, dimensions and list prices for the new Types D and E valves for blow-off service. Type D is a rotatable gate valve, which lifts clear of the seat before turning. Type E is compound screw-down. Bodies are semi-steel for 250 lb. or cast steel for 400 lb. pressure. They may be used separately, with other valves, or combined into a tandem unit. Copies of the bulletin may be had from Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa.

MEN, MONEY AND MERGERS. By George L. Hoxie. Published by the MacMillan Co., New York, N. Y. 6 by 4 in. 224 pages cloth, $2.50.

Business and social combinations are becoming more complex and the controversy that arises over the word capitalism is not whether it is needed but who shall own it, the state or individuals. Socialism and the extent to which capitalism can go socialistic to compensate for failure of our economic and social system are discussed by the author from an unbiased viewpoint, or, from what he considers unbiased for as he says perhaps no author can achieve this completely. The first part of the book is devoted to sketching today's social and political background with particular reference to the electric power utilities. He shows that countries have progressed in inverse ratio to their socialistic practices and that individualism, in which men who build our expanding industrial structure are neither appointed, elected nor born to the purple, is best. He concludes that the socialists however sincere and altruistic in their aims are unwitting enemies of society.

HANDBOOK OF THE NATIONAL DISTRICT HEATING ASSOCIATION, 1932. 6 by 9 in., 538 pages, flexible fabricoid binding, second edition. National District Heating Assn., Greenville, O. Price, $5.00.

Data and ideas compiled in this comprehensive book on district heating have been taken largely from the Association's proceedings and from the files of operating companies. The material has been selected for its usefulness in the management of district heating plants. The opening chapter relates the growth of this industry from its beginning in 1877 up to the present status. Other chapters give engineering data useful in calculating heating requirements, planning and designing heating plants and systems. One chapter is devoted to rates, another to sales activities and the twelfth and last to economical use of steam. While this volume is called a handbook the information has been expanded into a manual and textbook of particular value to those actively engaged in district heating work though helpful to anybody having heating problems to solve.

Power Plant Construction News

Ala., Blue Mountain—American Net & Twine Co., Blue Mountain, plans installation of electric power equipment in new addition to mill, consisting of two one-story units. Entire project will cost close to $60,000.

Calif., La Mesa—City Council is considering the installation of a municipal electric light and power plant. Estimates of cost will be made by Burns-McDonnell-Smith Engineering Co., 1031 South Broadway, Los Angeles, Calif., engineer, as well as recommended list of equipment to be installed.

Calif., San Bernardino—Southern Sierras Power Co., Riverside, Calif., is planning early installation of an underground transmission system on D Street, San Bernardino, estimated to cost about $40,000, with equipment.

Colo., Colorado Springs—City Council has authorized plans for a new municipal steam power plant for general service for city utilities. Estimates of cost being made. C. Truman St. Clair, Ferguson Building, is architect.

Fla., Pahokee—Pahokee Water Co. is considering installation of motor-driven pumping equipment and auxiliaries in connection with extensions in water supply system, including development of new source of supply. Entire project reported to cost over $50,000.

Ill., Belvidere—City Council is considering installation of a municipal electric light and power plant, and will have report made, with estimates of cost, at early date. Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Iowa, Milford—Common Council is arranging a bond issue of $80,000, proceeds to be used for installation of a municipal electric light and power plant. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, is engineer.

Ky., Paris—City Council is said to be planning early call for bids for proposed municipal electric light and power plant. Station is estimated to cost about $150,000 with equipment. Black & Veatch, Mutual Building, Kansas City, Mo., are consulting engineers.

La., Amite—Gulf States Crate Co., care of H. S. Weigle of Amite Bank & Trust Co., Amite, recently organized by Mr. Weigle and associates with capital of $250,000, plans installation of electric power equipment in proposed new plant for manufacture of fiber products. Entire project reported to cost over $65,000. Site for plant is being selected.

La., Kenner—East Jefferson Water Works District No. 1 is said to be planning early call for bids for pumping equipment and other machinery for waterworks station and supply system for East Jefferson Parish. Fund of $500,000 has been approved for project. Henry A. Mentz & Co., Citizens' National Bank Building, Hammond, La., are consulting engineers.

La., New Orleans—American Paint Works, 428 Josephine Street, plans installation of electric power equipment in proposed new multi-story additions to plant. Entire project reported to cost over $60,000. Rathbone DeBuys, Hibernia Building, New Orleans, is architect.

Me., Rockland — Rockland-Rockport Lime Corporation plans installation of electric power equipment in connection with proposed rebuilding of lime manufacturing plant, partially destroyed by fire recently. Loss about $75,000.

Md., Baltimore—Pennsylvania Railroad Co., Pennsylvania Terminal, Philadelphia, Pa., has approved plans for a new coal storage and distributing plant at Bolton Station, Baltimore, with installation of loading and other mechanical-handling equipment. Cost about $130,000, with machinery.

Mich., Saginaw—Board of Public Works is planning installation of motor-driven pumping machinery and auxiliary equipment in proposed municipal sewage disposal plant. Entire project reported to cost about $50,000. Francis Engineering Co., Saginaw, Mich., is engineer.

Minn., Morris—Common Council has called a special election to approve a bond issue of $150,000, for installation of a proposed municipal electric light and power plant. Plans for station are being drawn by Robert J. Torrens, Shubert Building, St. Paul, Minn., consulting engineer.

Minn., St. Paul—Department of Public Utilities, City Hall, Clyde R. May, commissioner, is considering construction of a city-owned electric generating station for service at municipal pumping station and water filtration plant. Estimated to cost over $75,000.

Minn., Sauk Rapids—Common Council is said to be considering installation of a municipal electric light and power plant, and will secure details and estimates of cost at early date. F. Agather is city clerk.

Mo., Kansas City—Sewall Paint & Varnish Co., 1009 West Eighth Street, plans installation of electric power equipment in connection with rebuilding of portion of plant, recently damaged by fire. Work is estimated to cost close to $50,000. Addison Brown is president.

Mont., Deer Lodge—Common Council plans installation of battery of turbine centrifugal pumps and auxiliary equipment in connection with new municipal waterworks; also, a 100,000-gal. elevated steel tank and tower. Entire project estimated to cost about $200,000. Burns & McDonnell Engineering Co., Interstate building, Kansas City, Mo., is consulting engineer.

Neb., Ainsworth—City Council is considering the installation of a municipal electric light and power plant, estimated to cost about $84,800, with equipment. Robert Fulton, 1717 D Street, Lincoln, Neb., is engineer.

Neb., Ralston—Common Council has plans under way for a municipal electric light and power plant. Expected to ask bids in near future. New unit will cost close to $85,000, with equipment. C. V. Barnhill, Lincoln, Neb., is engineer.

N. J., Bayonne—Pharma Chemical Corporation, 169 West Sixty-second Street, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire. Total loss estimated over $80,000.

N. J., Bordentown—City Commission is said to be considering installation of a municipal electric light and power plant, to be operated in conjunction with city-owned water-pumping station. Estimates of cost will be made in near future. Charles B. Rodgers, former city councilman, is active in project.

N. Y., Endicott—International Business Machines Corporation, Endicott, plans installation of electric power equipment in two new multi-story plant units, entire project estimated to cost about $350,000. Construction will soon begin. Company headquarters are at 270 Broadway, New York.

Ohio, Piqua—Val Decker Packing Co., Piqua, plans installation of electric power equipment in new three-story and basement addition to food products packing plant, entire project to cost over $100,000. Work will be placed under way at once. Anders & Reimers, Scofield Building, Cleveland, Ohio, are architects.

Okla., Durant—Ice Service Co., Durant, W. P. Gill, general manager, has plans for a one-story ice-manufacturing plant, to be equipped for initial capacity of about 20 tons per day. It will cost close to $30,000, with equipment.

Ont., London—Shell Oil Co. of Canada, Ltd., Toronto, Ont., plans installation of pumping plant, steel tanks for gross capacity of 4,500,000 gallons of gasoline, loading machinery and other mechanical equipment in proposed new bulk oil storage and distributing station at Port Stanley, vicinity of London, where site has been secured. Entire project will cost close to $200,000.

Ore., Albany—Albany Door Co., Albany, is said to be planning installation of electric power equipment in connection with proposed rebuilding of portion of millwork plant, recently destroyed by fire. Loss estimated at close to $60,000.

Ore., Stayton—Mountain States Power Co., Tacoma, Wash., has concluded arrangements for water power site at Stayton, and plans early construction of new hydroelectric generating plant, estimated to cost close to $75,000. It will replace a unit recently destroyed by fire.

Pa., Erie—Hammermill Paper Co., East Lake Road, plans installation of electric power equipment in proposed new one-story addition to mill, 130 by 260 ft. Revised plans are under way and bids are scheduled to be asked on general contract in fall. Entire project estimated to cost close to $100,000.

Pa., Mount Wolf—Superior Paper Products Co., Carnegie, Pa., plans installation of electric power equipment in proposed new branch plant for corrugated paper manufacture at Mount Wolf, entire project estimated to cost over $45,000. Structure will be ready for occupancy in the fall.

Pa., Philadelphia—Philadelphia Electric Co., Tenth and Chestnut Streets, has authorized construction of a new addition to Richmond power plant on Delaware River, to include installation of a 165,000 kw. turbo-generator and auxiliary equipment. Contract for prime mover has been awarded to Westinghouse Electric & Mfg. Co., which will construct the unit at its South Philadelphia Works, and awards for other equipment will be made in near future. Entire project will cost about $8,500,000, and is scheduled for completion in 1934.